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PUBLIC WORKS
and National Economic Stability

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THE fact that there is a relationship between public works and national economic stability has been definitely recognized by our government in the Recovery Act of 1933, which provides $3,300,000,000 for prosecuting such works over a period of two years. Only about 12 per cent of this fund is specifically allocated for highway work, but judging by the prevalence and intensity of the arguments regarding the roads to be improved with the highway allocation, I should say that about 97 per cent of the public interest is attaching to that part of the Public Works Program. When I speak of public works, therefore, I have in mind principally road work.

In the same way, economic stability, judged from the widespread expressions of public interest, means establishing and maintaining balanced budgets. That is to say, we, as individuals, groups and governments, are not economically stable except when we are paying for what we get.

During the past few years, we have all been more or less bewildered over the problem of keeping our outgo from exceeding our income. The one method, obvious to us all for maintaining a proper balance has been the reduction of expenditures, and the general application of this method has resulted in the spiral spread of unemployment throughout the length and breadth of the country. As timid individuals we, perhaps, had no other way open to us. As an organized people we became confused in the maddening convolutions of credit, currency and banking and simply failed to function.

Collective Responsibility for National Economic Welfare—Now that our government has accepted the principle of collective responsibility for the national economic welfare and is attempting to co-ordinate business and industrial organizations, together with public works activity, so as to banish unemployment, it seems fitting that we who are so intimately concerned with public work should understand the philosophy of controlled economy to which we are committed. Certainly we should have in mind a definite purpose to conform our road work with the aims of this new philosophy.

It seems to me that we must accept as fundamental truth the principle that we can supply no more of our wants, through the intercession of government or otherwise, than we, as a national group of individuals, are able to pay for. Also, it should be manifest that our ability to pay for what we want depends upon our capacity to produce, distribute and utilize the commodities and services that go to make up the objectives of our wants. It is equally manifest that to realize the full measure of this capacity we must intelligently apply our available

Coastal Highway U. S. 100 in San Diego County, California

man power to the task. Unemployment is wholly inconsistent with the idea of balancing budgets on a national scale. We cannot hope to increase our collective material means by curtailing production nor by limiting the hours of labor. Such means may be necessary at this time to secure a proper distribution of employment and may be warranted at any time as digestive stimulants to aid in absorbing a burdensome abundance of certain kinds of consumables, or as social influences designed to encourage fuller living. But they assuredly cannot be relied upon to re-establish for this country that economic supremacy which is ever dependent upon the intelligent application of effort.

Public Works to Utilize Surplus Labor—In setting out to recover economic equilibrium our government is, quite naturally at the beginning, making an effort to redistribute the burdens and adjust the supports of our economic structure so as to keep what we have from top-

A Highway in the Town of Milton, Mass.—Norwalk-Danbury Road.

pling. The economic philosophy behind these adjustments undoubtedly contemplates our continued development on a stable basis and with assured opportunity for all of us to enjoy such material prosperity as our energy and resources may merit. It also must contemplate appropriate and continuing provisions for storing that great national treasure available only through the utilization of our surplus labor. The only rational governmental plan for storing this treasure is in the extension of public works. Such extension, wisely planned and executed, means not only building up a balance on the credit side of our national budget, but also the creating of facilities that will in turn release more surplus labor for the more rapid extension of public works.

Some idea as to the quantity of surplus labor that might be employed on public works at this time without disturbing the commercial industries may be gained by considering our experience during the years from 1918 to 1929. In this 12-year period we kept our surplus labor occupied largely in creating commodities and services for foreign consumption that were paid for principally in promises that have since been defaulted. That was a rather poor way of storing our treasure, but we were getting along beautifully until we discovered the hole in the bottom of the bag. Actually we are no worse off, collectively, now than we were in 1918 because we have just as much of everything as we ever had, and more capacity for producing nearly everything. Furthermore, I am not even suggesting that we should have acted any other way than the way we did act. I am merely pointing out that we have just four short years ago completed a 12-year demonstration of this nation's ability to support itself handsomely and at the same time furnish to foreign countries an enormous quantity of surplus goods and services. The aggregate value of the goods and services thus furnished, for which we have small present hope of collecting pay, amounts to much more than enough to finance a public works program equal to our present one over a 12-year period.

Economic Circumstances of Past That Affected Labor—Many of us here can look back far beyond the period of the European War and subsequent inflation and recall other economic circumstances that affected the employment of labor and that enabled us to store our surplus more or less effectively. The development of railroads, the mechanization of industry, the manufacture of motor vehicles, are all examples of what I have in mind. None of these circumstances, however, came as a result of economic planning, and none, it seems to me, was sufficient to afford that measure of stability in employment and security for the individual in his right to earn and live that might have been afforded if private industry had at all times been supplemented by means of an appropriate and continuing national public works policy, always sensitive not only to the needs of labor, but also to the proper aspirations of our people for those services that build up community life.

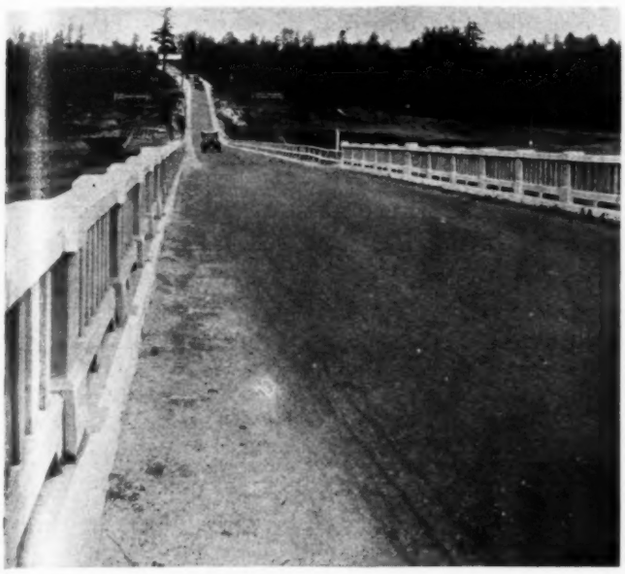
Now, of course, there isn't any automatic gauge by means of which we may measure accurately either the needs of labor or the popular aspirations for public improvements. Unfortunately, the two are not synchronous. When there is plenty of work to occupy all of our labor we generally feel prosperous and set up a demand for public facilities to the point of extravagance. This is illustrated by the billion dollar annual road programs that we put on when employment was plentiful. On the other hand, when our surpluses mount and unemployment spreads in private industry our tendency is to do with less public service and to demand reduction in the expenses of government. We have no plane of reference by means of which public sentiment may orient itself along lines of sound political economy. Public sentiment has met this situation, however, by forcing the delegation of additional discretion to the executive, thus loosing a new rational influence in government.

Purposeful Economic Planning to Guide Future Public Works Programs—Assuming that our national administration, with its broadened powers and purposes, will continue responsive to the dictates of intelligence and devotion to the public weal, I venture to forecast that never again will the public works activity in this country be left wholly dependent upon the fickle sentiment of successive national and state legislative bodies. Public work programs will, of course, continue to be based on legislation, but I think that hereafter we may count on our legislators to accept the guidance of purposeful economic planning to a much greater extent than has ever been the case heretofore. Such planning, in my judgment, cannot fail to make provision for a continuing national highway program as the major feature of a rational public works policy. There is not a community in the entire country that does not feel the need for additional highway facilities. Small vision is required to see the probable opportunity for carrying on road work with profit to the public for at least a hundred years; and that with due allowance for accelerating the rate of construction as compared to the present.

Transportation Systems Should be Co-ordinated—To my mind there is much significance in those provisions of the Recovery Act and regulations that make city

streets and railroad feeders eligible for Federal Aid. The old distinctions were largely artificial. Our transportation systems should be unified and co-ordinated. Streets, roads and railroads should each supplement the service furnished by the other, and it seems a proper function of the Federal Government to aid materially in developing toward that end. The gesture already made opens up an enormous field for public works and, at the same time, simplifies the problem of distributing activity without loss of effectiveness.

The question of how we are to pay for an ever expanding public works program, such as we are discussing, will no doubt impress itself upon the minds of many.



A New Hampshire Road—Daniel Webster Highway, Route U. S. 3.

My answer to that question is that we will pay for the public works whether we get them or not. I mean by this that we must somehow support our entire population, regardless of the proportion that we have unemployed. If, for example, we can produce merchantable commodities and services sufficient to meet the present demands of the whole population by employing only about three-fourths of our available man power, it is immediately apparent that we can properly and profitably employ the other one-fourth in the production of non-merchantable public improvements.

The Fundamental Question—The fundamental question is: can the average American scale of living be improved and stabilized effectively through a continuing national public works policy rationally adapted at all times to the availability of labor as well as to our common aspirations? If the answer is yes, then there is warrant for the expenditure, and the matter of distributing the burden of cost becomes a problem in taxation, to be handled, of course, with appropriate regard to the underlying purpose of maintaining a stable economic structure. The actual manner of levying and collecting the revenues for public works does not appear to offer a serious problem when we consider the enormous sums that we levied and collected during and immediately following the period of the great war.

Notwithstanding the bonds that were issued by our government, we, as a people, actually paid our way as we went, including the advances made to foreign countries. When it was all over we had as much material wealth as we had before and we didn't owe anything to any other country. There had been changes in the distribution of wealth, of course, and all sorts of changes in relatives values, but the average American citizen was better circumstanced economically at the end than he was at the beginning of the period in question. Presumably, therefore, we could have collected all that we spent during that period of heavy expenditure without issuing any bonds and without undue burden on our producers.

Another more or less classic objection to the idea of stabilizing employment by means of public work is based on the often repeated assertion that government cannot function economically. The answer to this objection is the record already established by the Federal Bureau of Public Roads and the state highway departments. If there is any privately owned utility in the United States that can show a comparable record of large scale public service furnished at a low rate of cost, its identity has not been disclosed. Public service investigations have been going on throughout the country and many privately owned utilities have been continuously on the defensive for the last several years. If they could have developed a favorable comparison with the state highway service, it seems to me that they unquestionably would have done so.

Conclusion—In conclusion, may I summarize the thoughts that I want to leave with you. They are:

First—The net measure of our depression losses is idleness. We cannot hope to attain economic stability except by assuring to all of our people the right to work and earn. Intelligent effort must be our reliance for producing and distributing goods and services as well as for balancing budgets.

Second—The most effective means open to democratic government for regulating employment is through public works. A continuing rational public works policy adapted at all times to our community aspirations, as well as to the availablility of labor, must be a part of any intelligent plan for controlled economy.

An Avenue of Eucalyptus Trees Bordering Orange Groves Along a Southern California Highway.

Third—The national and state highway organizations have demonstrated their ability to function honestly and effectively, and the extension of improved highways is needed and demanded everywhere. The highway officials, therefore, have an oportunity and a duty to broaden the guiding vision that inspires them so as to keep it commensurate with the full economic possibilities.

Acknowledgment—The foregoing is an abstract of an address presented Oct. 9 at the Annual Convention of the American Association of State Highway Officials.

Jersey City-Newark High Level Viaduct Pavement

THE last link of the New Jersey State highway, designated the Lincoln Highway, leading from the west end of the Holland Tunnel through Jersey City, Kearny, Newark and Elizabeth, to connections with the main highways to Trenton, Philadelphia, Pa., and beyond, was opened for traffic on Nov. 24, 1932. The highway is about 12 miles long and cost approximately $40,000,000. As present this highway carries 11,000,000 vehicles per year and is expected to become one of the most heavily traveled roads in the world. For the greater part of its length it goes through built-up sections of cities with heavy street traffic, through land developed for industrial and railroad purposes, and it crosses three navigable rivers. The highway is built throughout the greater part of its length so as to avoid grade intersections with other highways and streets and with railroads. One of the most important sections of the highway is the high level viaduct between Jersey City and Newark. For this section it was decided to use a concrete roadway surface integral with the concrete floor slab. The following description of this pavement is taken from a paper by Sigvald Johannesson, Designing Engineer, New Jersey Highway Commission, in November Proceedings American Society of Civil Engineers.

While the study of pavement type was under way, the design and fabrication of the steel structure had progressed so far that it became necessary to establish a definite slab thickness, before the exact type of floor-slab had been decided upon, and, for that reason, a thickness of 8½ in. was adopted as being that which might be used for a standard reinforced concrete slab.

Following this an intensive study was made of the various types of slabs that might be used, and several types were found suitable. The choice, therefore, depended on which would prove to be the most economical, and, for that reason, designs for four alternative types were prepared and submitted for bids.

Type 1 (Fig. 1), which was chosen eventually, is a concrete slab, 8½ in. thick, reinforced with fabricated trusses, composed of round bars welded together. Essentially, it consists of a top and a bottom chord of round bars with a web member made of a bar bent so as to form the diagonals of the truss, the various pieces being connected by pressure welding. In some cases the trusses are fabricated with single bars for top and bottom chords and with web member placed between two chords while in other cases each of the chord members consists of two bars welded to sides of web member at its panel points.

Type 2 was a series of inverted 5-in. T-beams, or half 10-in. H-beams, set closely together and tack welded so as to form a solid steel surface at the bottom the slab, and filled with concrete to a height of 2 in. above the top of the T-beams. This type of slab reinforcement is usually fabricated in depths ranging from 2½ to 3½ in. The 5-in. depth was required because it was thought that while the slab of a lesser depth might be designed to carry the required load, it was not entirely certain that the concrete in it would not be crushed, in time, by constant use.

Type 3 was a solid-bottom plate with ribs at intervals and a steel grating attached to them with its top surface at a height of 5 in. from the bottom of the plate; concrete was placed on top of the plate to a depth of 2 in. above the steel. Type 4 was a solid-bottom plate with welded trusses, 5 in. deep, attached as ribs, and concrete was placed to a depth of 2 in. above the top of the ribs.

In all four cases the reinforcement also involved transverse top bars secured in place in various ways and, in addition, transverse bottom bars were required for Type 1. Each type was carefully investigated and found to be suitable for the purpose. For Types 2, 3, and 4, however (which had an over-all depth of 7 in.), it was necessary to introduce fillers, 1½ in. deep, between the steel support and the floor-slab, in order to make them conform to the depth of slab for which the structure had been designed. This, naturally, added to the cost of these three types although, on the other hand, the volume of concrete required was less.

The trusses in Type 1 were designed to be spaced on 8-in. centers and to be 5 in. deep over all. The two top

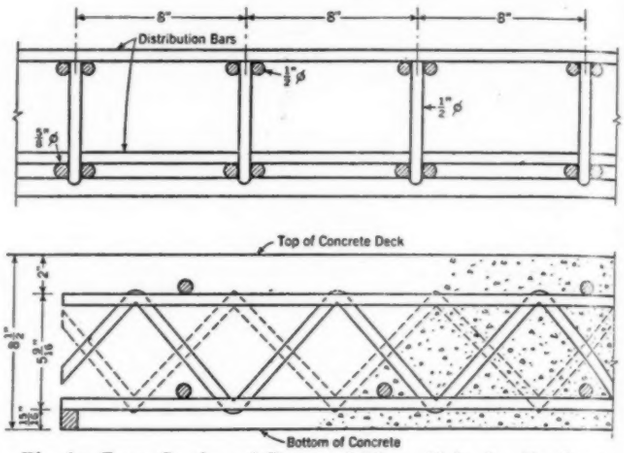


Fig. 1—Cross Section of Types of Floor Slabs for Roadway Surfaces.

bars and the web member were ½ in., and the two bottom bars, ⅝ in., in diameter. Rectangular spacing bars, as shown, were welded to the cross-beams on which the trusses were supported, and round top and bottom distribution bars, extending the full width of the roadway, were provided, as shown. In order to facilitate the work of erection and to insure exact spacing of the reinforcement, it was required that the trusses should be assembled in mats prior to erection by welding them together by the spacing and distribution bars. The length of the mats was required to conform to the distance between the primary floor-beams, which distance normally was 25 ft. The width was not specified, but left to the option of the contractor, subject to the approval of the engineer. The width of the mats actually furnished by the contractor was normally 10 ft., but it is probable that the erection would have been easier if the width had been about one-half that actually used. The reinforcement trusses were arranged to be placed longitudinally on the structure, because better wheel-load distribution could be thus obtained than with a transverse arrangement of the trusses.

The concrete for the slab was required to have a crushing strength of not less than 4,000 lbs. per sq. in., when 28 days old. Actually, the concrete furnished had an average strength of about 4,800 lbs. In computing the strength of the slab, the upper 2 in. of the concrete was not taken into account. When the time comes that it may be necessary to renew the wearing surface of the roadway it will thus be possible to remove this top layer without affecting the carrying capacity of the slab, and in this way a new wearing surface can be placed. It was thought that this new surface might be either concrete, or some type of asphaltic surface—or possibly some entirely new type of surface pavement which has not as yet been developed.

Successful RESEARCH *By a Tyro*

By HALBERT P. GILLETTE

THE Jack-of-all-trades is admittedly as poor a worker in a science as in a craft. But how often is it realized that most scientists are Jacks-of-all-trades even when they call themselves specialists? Here is one who is a recently graduated chemist and regards himself as anything but a Jack-of-all-trades. Yet the profession of chemistry embraces hundreds of varieties of specialists, so he is really a Jack-of-all-trades.

Here is another chemist of long experience who proclaims himself a specialist in coal-tar derivatives, but a little philosophic consideration of the matter shows that no man can be very much of a specialist where there are thousands of known derivatives of tar, and more are being found every year. Without carrying the illustration farther, it should be apparent that scientific specialization is purely a relative term. Hence it follows that in six months' time the continuous study of one scientific problem may make a man the greatest of living specialists in the science relating thereto. I will give an illustration.

In May, 1921, a young Canadian surgeon, Fred Banting, was given a laboratory bench, 10 dogs and the assistance of a medical student by the same of Best for eight weeks, at the expense of the Medical School of the University of Toronto. Banting had never been a researcher, and knew nothing about diabetes except the little that he had recently read, but that little included two facts that to him seemed to furnish a clue to the cure of diabetes. Moses Baron had found that when the duct from the human pancreas is blocked by gallstones the island cells of the pancreas remain healthy but that the digestive-juice cells degenerate; also that if the pancreatic duct of a dog is tied, the same thing happens. By September, 1921, or five months later, Banting had solved the problem of saving diabetic dogs from death. He created diabetes in a dog by tying the duct leading from the pancreas. Then, by injecting an extract from the pancreas of another dog or of a cow, he restored the diabetic dog to health. In February, 1922, he applied his treatment to a human diabetic patient with immediate success. That patient, Gilchrist, is alive and has been kept alive and vigorous by two daily injections of the pancreatic extract called insulin. The same is true of thousands of other diabetics. Therefore within nine months after his initial experiment on a dog, Banting had shown that he could at least halt the progress of diabetes in a human being. Yet when he first announced his theory of how to cure diabetes he had been asked by Professor Macleod whether he had better not begin by a study of pancreas anatomy and physiology, clinical diabetes and the chemistry of blood sugar, all of which might take years. Having spent those years, Banting would then be regarded as equipped to solve the problem. Fortunately Banting clung to his belief that no such preparation was needed, and fortunately Professor Macleod gave him an assistant, a few dogs, and a few weeks' use of a corner of a laboratory.

The story of Banting's victory reads like a fairy tale, both because he succeeded where more learned men had failed and because success was so quickly won. But the history of science contains many a similar tale of speedy research success by men rated as tyros. Does this not suggest that scientists should revise their ideas both as to what constitutes ignorance and as to the length of time it may take to acquire wisdom?

There has always been, and there still exists, an undue worship of an extensive knowledge of numerous facts. But the truth is that a knowledge of a very few facts often suffices to solve a given scientific problem, when to that knowledge is added a glowing conviction that those few facts will suffice. At times it happens that the few essential facts are generally known, but that no one has undertaken to apply them. Professor Macleod knew the two facts that Baron had discovered, but did not believe in their sufficiency as Banting did. Baron's experimental facts were all that explorer Banting needed as a compass by which to guide him to his great discovery.

At other times it happens that no one is in possession of the few facts needed as guides to successful research. Such was the case when Goodyear started out to find a way of vulcanizing rubber. Only blind experiment was open to him as a way of finding a guiding clue. Yet faith in such "blind" experiments was justified by many an analogy. He knew that the property of a substance is often greatly modified by even slight admixtures of another substance. So he experimented "blindly" with rubber till he got what he sought.

In the case of "blind" experiments, wide knowledge is often helpful, but not infrequently it is a hindrance, for it may lead the experimenter to reject an idea because it seems to conflict with some established theory. Hence it follows that researches should be conducted independently both by learned men and by tyros.

It is comparatively easy to find learned men who seem capable of successful research. But how is one too select a tyro who is likely to solve a research problem? Up to date, only two principles are available as guides in selecting a tyro: First, the principle that previous research by a man who began as a tyro indicates possession of qualities that are apt to make him successful in any research. Second, the principle that a tyro having great and persisting faith in his own research ability possesses that faith because of research ability. Absence of faith in one's own ability to solve a problem is usually good evidence of absence of that ability.

Many men verbally proclaim a faith in their own ability which they speedily deny by their own actions. They give up in despair shortly after starting with great elan. The quitter lacks faith in himself. Without such faith no great scientific discovery seems ever to have been made.

Perhaps Professor Macleod reasoned thus when he gave Banting "rope enough to hang himself"—or else to climb out of the dark pit of ignorance into the light of knowledge.

At the end of eight weeks Banting had exhausted the small sum of money appropriated by the University of Toronto for his research. He sold his own surgical instruments and office furniture, to pay his assistant Best and to support himself. Only a few weeks would this additional money last, but "a giant tractor couldn't have pulled Banting away from his little black bench now." Just ten weeks and two days after he had started his research, an injection of pancreatic extract revived a dying diabetic dog, and a blood test showed the cause of revival—"his sugar was down," and was therefore

being burned up. So improbable was it that this was an accidental coincidence that Banting thereafter had no doubt that his theory was correct. Victory was not yet complete but it was in sight.

Rarely, if ever, has a disease been conquered so quickly as in this case. But there are many instances of just as speedy verification of a tentative scientific theory. Perhaps I may be pardoned for citing an example from my own experience.

Nearly thirty years ago I conceived the idea that when two atoms unite to form a molecule, each may contribute a plus or minus number of calories in causing the resulting heat of formation. Within six hours after this theory had been conceived, I had proved that it held true as to a dozen metals and half a dozen acid radicals. In this case only a paper and pencil laboratory was needed, plus a knowledge of algebra and a table of "heats of formation." Then another law disclosed itself, namely, that the metal, or other base, that has a given atomic heat-valency will chemically displace one that has a lower heat-valency. (Transactions American Institute of Mining Engineers, 1904, page 702.)

Samuel Morse is said to have solved in a day the basic problem of telegraphy. He was a tyro in science if ever there was one. At the age of 40 he had attained European recognition as an artist of ability and was homeward bound when he chanced to meet on the ship several men interested in electricity. He broke into their conversation with, "If the presence of electricity can be made visible in any part of a circuit, I see no reason why intelligence may not be transmitted by electricity." Although the statement received no denial, it aroused no interest—except in Morse. In a few hours he had made drawings of his proposed telegraphic instruments, which remained fundamentally unchanged when he applied for a patent five years later. Those five years he spent in devising ways of perfecting his idea and in experimenting, but like Banting, his initial victory was speedily attained.

When instances like these are cited, it is often replied that while pioneers in science have often been tyros, science has emerged from the pioneer stage; therefore the tyro no longer has much chance of success in competition with the scientist or engineer familiar with the field in which further exploration is about to be made. Yet generation after generation of tyros have arisen to refute that doctrine. I doubt not that the tyro will never cease to be an important factor in research. All that any science contains is slight compared with what remains to be discovered. If so, no science will ever emerge from the pioneer stage.

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Welding Aids in Weight Reduction of Remodeled Bridge

Arc welding played an important part in reducing the weight of the recently remodeled and widened University bascule bridge at Seattle, Wash. The bridge, built some 17 years ago, originally had a 40 foot roadway for double-track street car service. Vehicular traffic had increased from 8,000 per day in 1919 to 38,000 per day in 1931 when it was decided to widen the bridge.

Widening was accomplished by building roadways outside the bascule trusses as shown in Fig. 1. These traffic lanes are supported on arc welded brackets securely tied to the floor beams through slots cut in the vertical truss members. The brackets have taper bottom flanges (Fig. 2) and vertical stiffeners arc welded to the web. The stringers extend through slots in the bracket webs and have plates welded to the upper and lower flanges.

Hand rails for the bridge were also arc welded.

Welding was done by the Puget Sound Bridge and Dredge Co., contractors for widening of the span. All welding was done with equipment manufactured by The Lincoln Electric Co., Cleveland, O.

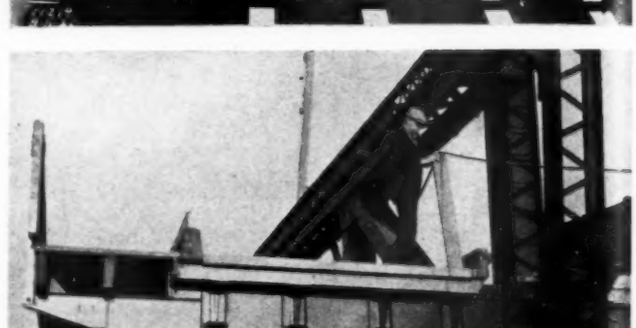

Fig. 1 (Upper)—View of Arc Welded Brackets and Stringers for Outer Roadway. Fig. 2 (Middle)—Bascule Leaf Raised to Show Outer Roadway Brackets. Arc Welding Was Used for All Shop Fabrication. Fig. 3 (Lower)—Bridge After Completion of Widening. Open Mesh Steel Flooring Was UsUed to Reduce Dead Weight.

160-Mile Elevated Super-Highway System Proposed for Chicago

A COMPREHENSIVE system of elevated highways is proposed for Chicago in a study completed recently by Dr. Miller McClintock, Director of the Albert Russel Erskine traffic research bureau of Harvard University. The plan calls for the construction of 160 miles of elevated highways in Chicago within the next 25 years at a cost of approximately $100,000,000. Fifteen miles of highways are proposed for immediate construction at a cost of approximately $8,000,000, exclusive of certain easements and special bridge work. For this initial program, the report points out that there is $8,000,000 a year available for road construction in Chicago from the city's and county's share of the gasoline tax revenue.

The report does not recommend specific routes for the entire system to be built in 25 years, but it does propose their general directions as indicated by studies of traffic volumes, origins and destinations of motor travel, and surveys of transportation economics.

It proposes north and south elevated highways, running from city limits to city limits, placed about two miles apart. Between the radials stretching northwest and southwest from the loop would be three east and west routes in addition to the Randolph-Lake street project. The lake front outer drive would be continued from Evanston to the Indiana line.

As a financial policy for this construction, the study recommends a "pay as you go" principle, with the users doing the paying through existing motor fuel taxes. The report goes into detail in opposing any special assessments or additional property taxes for the improvements, pointing out the inequity of many special assessments of the past.

The study was made for the Chicago City Council Committee on Traffic and Public Safety of which John A. Massen is chairman. The notes following are taken from the report.

Why This Limited Way and Plan was Selected.—As a result of the studies the conclusion was reached that: "limited way construction affords the only satisfactory method of solving the major traffic problems of the Chicago metropolitan region both because of the direct economies which it makes possible and because it is the only type of construction that can provide efficient trunk line service in congested areas."

A limited way is defined as " . . . a roadway for vehicular traffic upon which there is no cross-traffic due to a continuous elimination of grade crossing and a roadway which provides no direct access to abutting property."

This type of construction, in comparison with surface route construction, was analyzed exhaustively by the engineers for the Committee on Traffic and Public Safety.[1]

In brief, the studies indicated that a limited way, because of the physical elimination of various frictions inherent in surface route operation, has an effective discharge capacity per lane which is not less than 80 per cent greater than that of a surface route. They show that over-all surface route speeds in urban areas cannot be expected to exceed 20 miles per hour under the most favorable conditions, whereas limited way construction, with present vehicle types, should afford, with greater safety, speeds in excess of 40 miles per hour and ultimately such speeds as vehicles may be capable of developing.

Since limited ways physically preclude the possibility of certain types of accidents, the studies indicate that every limited way constructed will produce a very large accident saving.

The studies further reveal that, on the basis of cost experience in the widening of major routes of travel in Chicago in the past, traffic capacity can be purchased for far less money by limited way construction than through surface route improvements.

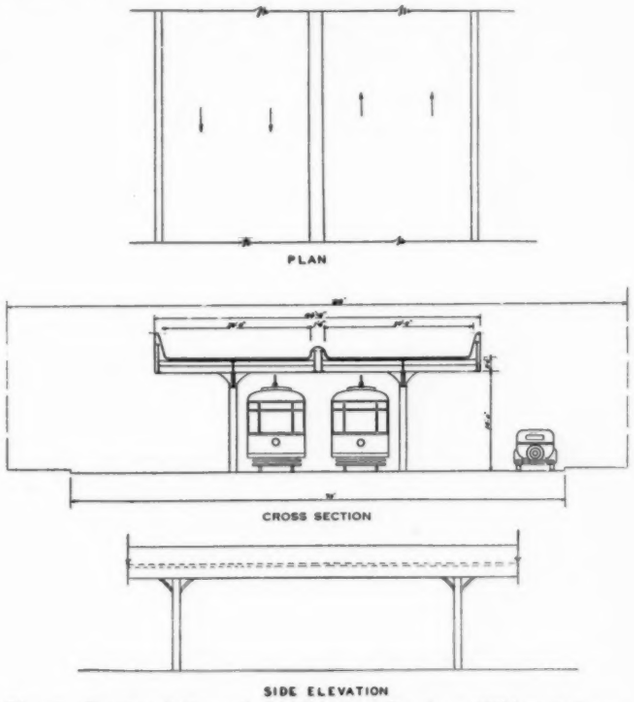

Fig. 1—Proposed Four Lane Construction in a Widened Street.

Elevated Limited Way Selected.—The bridge type of elevated structure with steel or concrete frame was selected. Thus the planning of a system of limited ways for the greater Chicago traffic area offers one of the first practical opportunities for incorporating in a system of motor ways all of those elements necessary for an ideal adjustment of the roadway to the operating characteristics and requirements of modern automotive traffic. Any surface route design must, even under the most ideal conditions, be a compromise between the requirements of automotive traffic and the necessities presented by problems of pedestrian traffic, street car traffic, subgrade conditions, drainage, general purpose illumination and many other conflicting factors.

Accelerating and Decelerating Lanes.—By the elimination of direct access to abutting property, the limited way removes a serious friction found in all surface routes. However, on any roadway there must be opportunities, at sufficient frequent intervals along the route, for vehicles to enter the roadway and to leave it. Under the McClintock plan, each flow entering a limited way is provided with an acceleration lane not less than 300 feet

in length. This acceleration lane is parallel with, at the same grade of and immediately adjacent to the outer working lane of the limited way. Thus, a vehicle entering a limited way from a connecting ramp is accelerated to normal speed in a lane outside of the working lanes of the limited way and enters the outside working lane by interweaving at a speed approximately that of the traffic movement in the working lane.

Similar considerations have governed the design of decelerating lanes. A driver, desiring to leave a limited way, places his vehicle in the outer working lane upon his approach to an exit. A decelerating lane is provided for a distance, not less than 300 feet in length, preceding the approach to each exit ramp. This decelerating lane is parallel with and at the same grade as the outer working lane of the limited way. The driver moves into this decelerating lane at normal speed and the entire braking

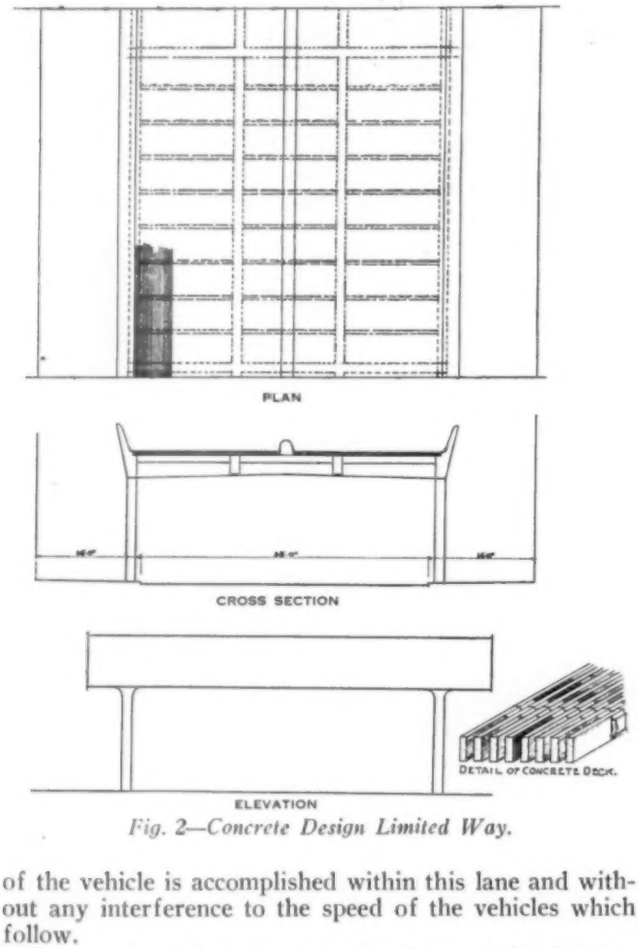

Fig. 2—Concrete Design Limited Way.

of the vehicle is accomplished within this lane and without any interference to the speed of the vehicles which follow.

The result of the use of accelerating and decelerating lanes is that the working lanes of the limited way are free at all times from the more serious interferences resulting from traffic entering and leaving. This element of design is important not only for the convenience and safety involved but, likewise, for economy in construction. It makes possible a capacity on a four lane limited way which could otherwise be obtained only by a six lane structure.

Roadway Cross-Section.—A fundamental consideration in the design of a modern motor way is the cross-section of the roadway. The nationally accepted standard for traffic lane width is 10 ft. and this has been used as a base in all of the designs presented in this report.

Since the proposed structures are elevated, it is essential that their outer edges be provided with guard rails of adequate strength to give protection and of such design as to make possible the operation of vehicles in close proximity to them to the end that the full width of the roadway may be utilized effectively. This guard rail of formed metal or precast concrete should be designed in such a manner that its inner edge meets the running surface of the roadway in an easy curve. This curved design encourages motor vehicle operators to drive in closer proximity to the rail than would be the case if its inner edge were a vertical surface. Indeed, with this design it is entirely possible for the wheel of the vehicle to actually impinge on the lower portion of the rail without serious consequences and with only a gradual deflection of the wheel from the rail. The guard rails should be approximately three feet, six inches in height which is entirely adequate to give protection and a necessary sense of security. A typical design for these guard rails is shown in the cross section of proposed four lane construction in Fig. 1.

Another essential feature in cross-section design is the medial fin or dividing strip in the roadway. This is considered an absolute requirement in design for high speed automotive roadways. It provides for an absolute alignment and separation of opposed streams of traffic. The first result is a greater regularity in the alignment of vehicles in each of the opposed streams as it provides drivers with a fixed point of orientation and precludes a possibility of overtaking movements in such a manner as to cause confusion in the flow of traffic in which the vehicle is moving.

A second and more important advantage is to be found in the complete elimination of the possibility of head-on collisions which are a frequent cause of serious and fatal accidents. Since opposed streams of traffic are physically separated, it is impossible for vehicles operating in opposite directions to come into contact. The medial fin or dividing strip should be made of formed metal or precast concrete approximately 18 in. in height with a mean width of not less than 2 ft. and with curved sides similar to those for guard rails. A typical design for a medial fin is indicated in Fig. 1.

Roadway Surface.—In the selection of an ideal roadway surface for an elevated limited way there are several factors which must be taken into consideration. Some of these are applicable to modern automotive roadways of any character and others are especially important in the designing of an elevated structure. The factors considered in the selection of the pavement were: Smoothness, flatness, friction coefficient, wearing qualities, drainage and snow removal qualities, dead weight, and obstruction to light and air. Regarding the type of surface proposed, the report states:

"It is impossible, when one bears all of the essential features in mind, to escape the conclusion that an open grid pavement of steel or concrete offers advantages which must be seriously considered. This type of roadway may be constructed with an entirely flat surface. This is due to the fact that drainage and snow removal are entirely automatic. The grid may present upwards of 75 per cent of the total area in open interstices between its component members. Thus, rain will fall through the pavement to all intents and purposes as though the pavement were not there. Similarly, snow will not be collected by the pavement. Ice accumulation will be at a minimum as the bearing surface provides slight area for its accumulation and, in addition, the tire bearing upon the wearing surfaces will be relatively high, tending to crush ice particles as they form. The rigidity of the surface and its fabrication as an integral part of the structural frame will prevent distortions and resultant destructive impacts. The effects of erosion in steel decking can be mitigated by any one of numerous

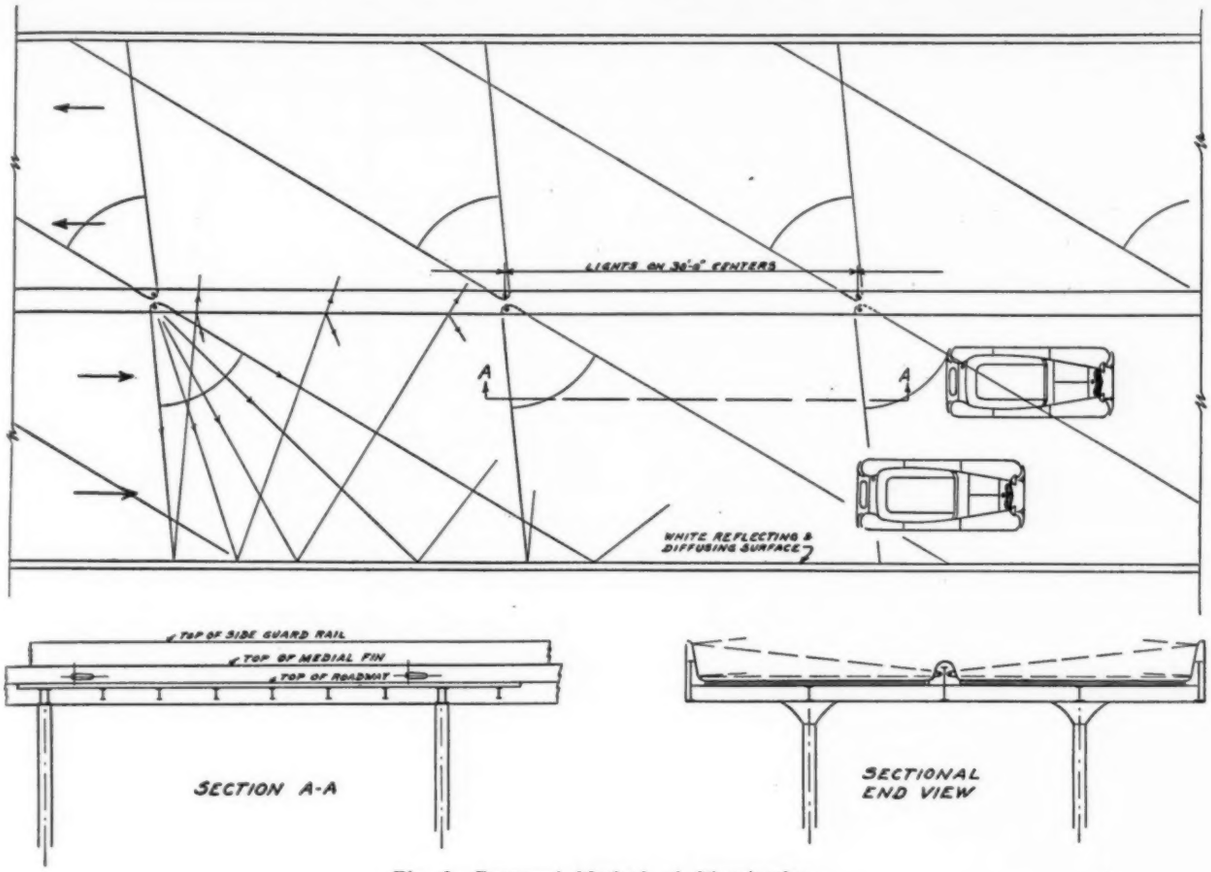

Fig. 3—Proposed Method of Illumination.

pretreatments of the non-wearing surfaces and the bearing surfaces themselves will automatically be scoured by tire contact. With reasonable care, such a surface should have a useful life of upwards of 50 years without distortion or material reduction in strength.

"Open grid deck may be designed so as to be practically non-skid in operation even with smooth-tread tires. A large portion of the deck is in open space and into these interstices the tire surfaces tend to form themselves under the pressure of the vehicle weight, making in natural operation a continuous non-skid impression on the tire. Open grid concrete deck may be designed with a dead weight of approximately 60 per cent of that of solid slab pavement. Steel grid deck may be designed with a dead weight approximately 16 per cent of that imposed by solid slab pavement for maximum vehicle loadings. Grid deck permits a lightness of design which makes the structure less obstructive and less costly as is shown in detail by the cost estimates in Chapter Four. The light and air advantages of grid deck surface are self-apparent. With a large portion of the surface open, a large amount of natural light and air will be passed.

"The suggested use of open grid surfaces for elevated limited ways is thoroughly justified by the above considerations. This report contains many innovations in design of limited way planning. It is realized that the entire project of limited way construction is, in itself, an innovation and will, of necessity, require for its full perfection a departure from many established and orthodox methods of design and construction. The use of open grid pavement is, however, by no means a radical proposal. Steel grid construction has been used for many years for bearing surfaces of all kinds. Recently it has gained wide-spread recognition for bridge deck and other vehicle surfaces where strength and lightness are important considerations. Preliminary studies have shown that many existing bridges could be double decked to accommodate limited ways without exceeding allowable unit stresses if the present deck were made lighter by substituting open grid pavement for the old surface and thus substantial economies would be achieved.

Ramps.—The essential function of limited ways is to carry large volume, high speed traffic between various districts within a city. They are, primarily, through routes and should not be considered as especially useful for local traffic except under special conditions. The fundamental aim of the limited way is to facilitate both through and local traffic by segregating their planes of operation. It is apparent, however, that provision for access to limited ways only at their terminals would partially defeat the purpose for which they are designed. Access to the limited way must be provided at those locations where there is an established or anticipated demand for entry.

As the type of limited way recommended for general purposes is elevated, access must be provided by means of ramps. These should be at no more frequent intervals than are required for connection between the limited way and major flows of traffic normally destined to use it. Too many ramps would result in unnecessarily increasing cost and, likewise, in creating a temptation to use the limited way for purely local traffic thus encumbering its capacity and decreasing its efficiency.

Side ramps are proposed for normal construction. The ramps will be connected with the decelerating or accelerating lanes, previously described, and will descend from the level of the limited way structure to a connecting surface street at a grade not to exceed approximately 6 per cent. The ramp proper may be built parallel with the structure or may be at an angle to it. In many cases

this latter method is recommended for lessened obstruction to surface operation and for lower cost of construction. An angle ramp will descend into a cross-street or alley or into an area adjacent to the street or alley acquired for the purpose. Each ramp will be one way in operation, that is, either up or down exclusively. No ramp should exceed 11 ft. in width of roadway, thus providing free operation for one lane of ascending or descending vehicles and precluding the possibility of overtaking and passing. Where ramps connect with accelerating or decelerating lanes at an angle the ramp roadway should be given sufficient width of roadway to accommodate the turning movement of the vehicle. Single lane entries and exits are considered essential both for safety and for the efficient operation of the accelerating and decelerating lanes. Where the entry or exit requirements are greater than can be accommodated by single lane ramps, several ramps of single lane design should be provided at suitable spacings. This has the effect of protecting not only the limited way efficiency but likewise prevents the overloading of surface route connections.

In designing terminal ramp connections the practice should be followed of providing ramp capacity, in terms of roadway width, not less than two times the roadway capacity, in terms of width, of the limited way and of distributing the ramp connections to various adjacent surface route connections. This should permit the limited way to collect its full working load at origin terminals and to distribute its full working load at destination terminals without delay.

Illumination.—The design of a limited way for the exclusive use of vehicular traffic makes possible important departures from orthodox practices in street illumination. The only requisite for illumination in a limited way is an adequate lighting of the roadway to provide for comfortable and safe operation. It should be of such character that vehicles may be operated with such minor lights as may be necessary to identify them. In accordance with this aim, there is proposed a system composed of projectors set into the medial fin, augmented by white reflecting and diffusing surfaces placed continuously along the medial fin and the inside surfaces of the guard rails. This design is illustrated in Fig. 3. It has several outstanding merits. No source of light is exposed to the eyes of any driver. The units are designed in such a manner as to project the light beams across the roadway and in the direction of traffic flow. No light is wasted as it is all confined within the roadway area and is augmented by the continuous reflector strips mentioned above. These strips have the dual advantage of providing a highly visible continuous marker of the margins of the roadway and of augmenting the illumination by reflecting and diffusing the light beams thrown against them.

Aside from the simplicity and effectiveness of the method it should be noted that it is very economical of electric current consumption.

Cost Estimates.—The report recommends that the base routes proposed with the exception of the connection between South Chicago Ave. and Illinois Blvd., be designed for passenger vehicle loading. The cost of such structures is estimated at $431,000 a mile. Providing for truck traffic, which constitutes only 10 per cent of the city's traffic, would increase the costs 50 per cent. This estimate of $431,000 per mile, the report points out, is only 15.5 per cent of the cost of equal traffic capacity gained in street widenings, as illustrated by the additional traffic lanes which were obtained in the Western avenue, Ashland avenue, and La Salle street improvements. A

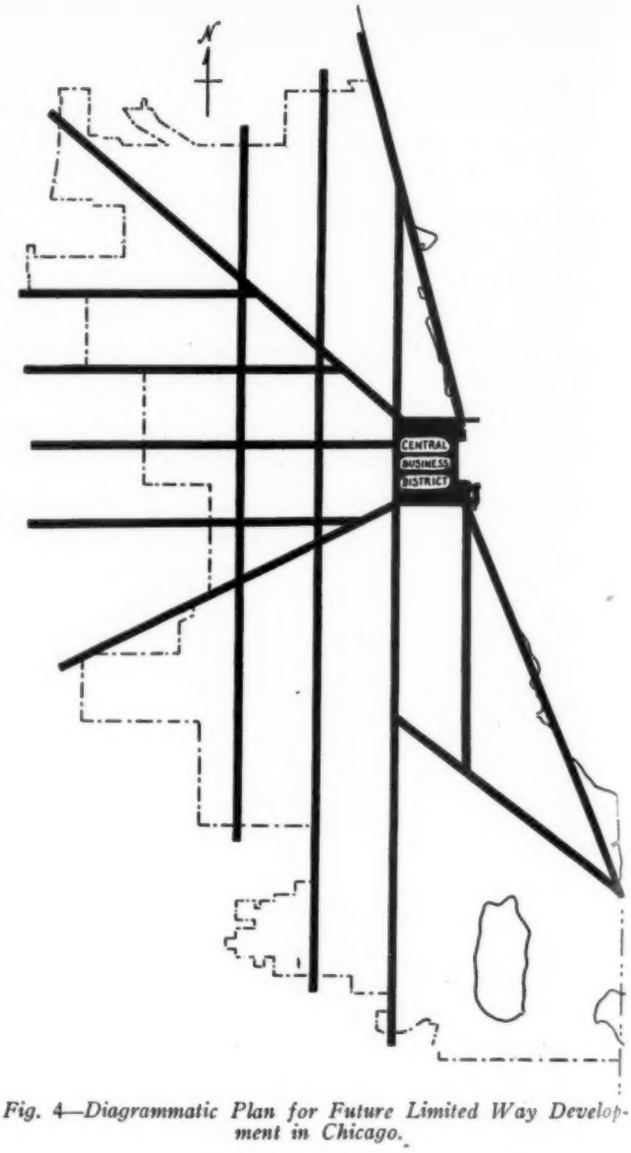

Fig. 4—Diagrammatic Plan for Future Limited Way Development in Chicago.

comparison is also made of the cost of paving two parallel streets without widening to be used for one way traffic systems and it was found that the cost per mile of the elevated highway is only $92,208 more than one way surface pavement of equal traffic capacity.

The report gives the following estimates for various types of loadings:

FOUR LANE LIMITED WAY WITH VARIOUS LOADINGS—STEEL STRUCTURE WITH CONCRETE GRID PAVEMENT

	H20 Loading Per Mile	H10 Loading Per Mile	Passenger Loading Per Mile
Steel	$240,000.00	$161,000.00	$114,000.00
Concrete Grid Deck[3]	259,000.00	175,000.00	160,000.00
Foundation	41,050.00	30,000.00	23,000.00
Concrete Railing	57,000.00	57,000.00	35,000.00
Lighting	20,000.00	20,000.00	20,000.00
Street Adjustments, Ramps, etc.	140,000.00	112,100.00	102,700.00
	$767,050.00	$555,100.00	$454,700.00[3]
Less for Steel Grid Deck[3]	100,000.00	79,600.00	23,700.00
	$667,050.00	$475,500.00	$431,000.00[3]

Referring to the cost estimates the report states:

"The analysis of basic structural elements reflects no attempt to be exhaustive. It is intended, merely, to dis-

close relative values in broad outline. Emphasis is placed upon the four lane type of construction because this type appears to afford the maximum of possibilities for limited way construction in Chicago.

"The references to materials which are made are not intended as an indication that other materials are unavailable. Innovations in the use of materials as well as in type and design of construction are to be expected. Utility and cost should be the determining factors.

"Because of the uncertainties as to material and labor costs, no presentation of cost data can possibly be conclusive. It is desirable, however, that data be submitted which will give some definite impression as to the expenditures required for the construction of limited ways embodying the essential structural features.

"The cost estimates set forth are preliminary in character but it is believed that the figures are liberal and that the cost of construction and the elements composing them will not exceed the amounts indicated. Material and labor costs were taken as of 1931 and may be higher in the immediate future. Various types of structures are, accordingly, presented herewith with their unit costs."

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16-Yd. Dump Trucks Used at San Gabriel and Boulder Dam

What is stated to be the largest dump trucks ever used on a construction job are employed at Boulder Dam and San Gabriel Dam. On these jobs the contractors are making use of Mack Model AP super-duty trucks with bath-tub type dump bodies of 14½ and 16 cu. yds. capacity.

One of the unusual features of these trucks is an arrangement whereby the driver is enabled to leave the confines of the driver's compartment, and, standing on an extended platform with guard rail, left of the driver's seat, have perfect control of the truck's movements while backing. This is accomplished by means of an auxiliary throttle and air brake controls. Since much of the driving is in reverse and the dump bodies are so high and wide that the driver cannot possibly ascertain his proper maneuvers from the customary position, this "crow's nest" as it is termed has proved extremely helpful in avoiding accidents and speeding up truck movements.

Truck with 14-Yd. Quarry Body.

Typical of the gargantuan proportions of the main-structural elements of these huge trucks is the super-duty rear axle, a massive heat-treated, chrome-nickel steel, one-piece drop forging, bored out to form a tube, with outside diameter of 6 ins.—the largest of its kind ever used in motor truck construction. The channel frame of these trucks is 8 ins: deep, 5/16 in. thick and has a 3-in. flange. In addition there is a full channel reinforcement from the rear of the front spring hanger to the front of the jackshaft. This reinforced frame is mounted on mammoth springs, those at the rear, mounted under the axle, being 55 ins. long, 5 ins. wide, each of the 14 leaves having a thickness of ⅜ in. Helper springs mounted above the axle have an effective length of 36½ ins., are 4 ins. wide and have 10 leaves, ⅜ in. thick.

The tires on the rear of these trucks are 40x14 dual solids, which means that altogether they present a width of 4½ ft. of rubber tread to the ground.

Braking ability is provided by four-wheel air brakes, 5 ins. wide and 20 ins. in diameter. Both rear service and hand brake shoes are contained in the same drum, side by side and are actuated by separate cams. A total braking area of 904 sq. ins. is available for service braking since all six of the wheel brakes are actuated in unison by six Westinghouse brake chambers. For hand braking, slotted linkage is provided to operate the secondary brakes in the rear wheels mechanically.

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Concrete Pavements Designed to Meet Traffic Conditions

An economy plan of concrete pavement construction was set forth in detail by Frank T. Sheets, Consulting Engineer of the Portland Cement Association, at the recent annual meeting of the association. The plan calls for concrete pavement built at reduced costs by designing pavement slab to meet traffic conditions.

In explanation Mr. Sheets stated that this progressive step was taken after an extensive analysis of data on all matters having to do with pavement construction and traffic loads. He said, "No highway engineer would think of building for ordinary highway service a bridge capable of carrying the heaviest railroad loadings, nor would highway loadings be a proper criterion for a railway bridge design.

"A pavement slab is an engineering structure. It is capable of almost as exact analysis as bridges and other structures. Yet we commonly see pavement cross sections suitable for the heaviest primary road traffic used indiscriminately on roads of medium or light traffic. We also see inadequate designs subjected to heavy duty service. This is a wasteful and unscientific practice.

"Therefore, the first logical and essential step in highway design is to determine the loads which the pavement will reasonably be called upon to carry.

"The volume and character of traffic determine the width of the pavement, and the sizes and frequency of the various wheel loads form the basis for economical structural design."

Mr. Sheets pointed out as another essential a careful study of pavement stresses and the ability of concrete to endure many thousands of the stresses which would result from the infrequent very heavy loads which are only a small percentage of total traffic. In this connection Mr. Sheets announced simple formulas for computing these stresses and revealed the discovery of a new method of evaluating the resistance of concrete to fatigue or repetition of stress and thus producing a pavement of adequate life at minimum cost.

Winter Maintenance and Ice Control On Highways

By E. J. VAUGHN

Maintenance Engineer, Oakland County Road Commission, Pontiac, Mich.

THE Detroit Metropolitan Area, comprised of Wayne County, in which Detroit is located, and the four counties immediately adjacent to Wayne, contains a population of 2,300,000 people. In this area are 2,600 miles of improved state and county highways. Of these improved roads, 1,500 miles are cement concrete pavements, including all of the main, arterial trunk lines which supply Detroit and its surrounding territory with the necessities, not only of commerce, but of life itself.

For example, all the milk consumed in the city is transported over these roads and the bread of the thousands living in this district is distributed daily over these same routes. Imagine the picture of inconvenience, even the extremity, to which this concentrated population would be subjected if the daily and uninterrupted use of its highways was withdrawn for 48 hours through some unforeseen calamity! The direct effect on the normal infant death rate in this area if the fresh, daily supply of milk from the outlying territory surrounding this metropolitan district were to be suddenly cut off, if only for two days, without question would be appalling.

Yet for several months each year, the threat of such a calamity hangs over this great industrial area. It is a threat comparable to a huge conflagration. That peril is the hazard of icy pavements.

This danger is particularly threatening in the Detroit area, furthermore, because of the dense automobile traffic, the combined motor vehicle registration of Wayne and Oakland Counties alone being exceeded in 1929 by only 14 state registrations. With this realization, the maintenance organizations of the counties in this area are fully aware that any unusual conditions affecting the full and uninterrupted daily use of the improved highways here will directly affect the lives of the inhabitants of this area.

Speedy Results Essential.—Sudden appearance of ice conditions on any road in such an area must be met with the same speed and efficiency expected from the fire or police departments of any large city when confronted with an emergency that menaces the peace or safety of the residents. There is no time to stop and consider costs or methods. Methods must be planned in advance; and they will not be satisfactory if they will not give speedy results. They will not be good if they bring more lasting harm than immediate benefit. They will not be acceptable if the same ends can be accomplished by other means entailing less cost without loss of time.

Considerable discussion has been held about the advisability of using calcium chloride for ice removal on cement concrete pavements, though there is no doubt in any well-informed highway official's mind but that the speedy removal of ice, or at least the blanketing of its possibilities for causing accidents and delaying traffic, is not only desirable but imperative. Until a better method of removing the highway ice hazard, or a better material, is found, however, maintenance departments will continue to use methods which, from their own experience, have proven most efficient and practical.

First Use of Calcium Chloride for Ice Removal.—Calcium chloride was first used in southeastern Michigan to remove ice in the winter of 1924-25. Just where it was first used, or by whom, cannot be definitely ascertained. In that winter the General Motors Truck Corporation used clear calcium chloride on portions of their testing track near Milford, Mich., in Oakland County. Also, in that same winter, the Oakland County Road Commission tried clear calcium chloride in at least one place on a pavement under their jurisdiction. The term "clear calcium chloride" is used to differentiate between a mixture of sand and calcium chloride and of calcium chloride alone.

In August of 1925 the writer was assigned to the six southeastern counties of Michigan as general supervisor of maintenance on state trunk line highways for the Michigan State Highway Department. At that time in that area of Michigan there was considerable scale on many pavements, regardless of age or whether county or state constructed. Since calcium chloride had then been used in only a few places, certainly there was much scale for which it could not be held accountable.

In the winter of 1925-26 more places on the public highways were treated with calcium chloride for the removal of ice; but it was used in a different manner than in the previous winter. It had been the practice in this locality for some seasons past to sand any pavements which became icy at particularly dangerous spots, such as sharp turns, steep grades, railroad grade crossing and important highway intersections. Later on, as their use became more general, all intersections protected with traffic signals were included in this list.

While sand can be procured quickly at several commercial gravel pits in this locality at any time through the winter, stock-piling at convenient locations provided more rapid expedition of sand in emergencies. Our Michigan winters always brought trouble through freezing of these stock-piles. An interesting phase of our present practice of mixing sand and calcium chloride for ice removal work is the deep conviction, reached after interviewing many men who were in direct personal contact with this operation in the field, that calcium chloride was first mixed with sand with no particular thought as to its merits as an ice remover, but entirely because of its ability to prevent the sand stock-piles from freezing.

Preventing Sand Stock Piles from Freezing—Experience proved that sand containing 100 lbs. of calcium chloride to the cubic yard would not freeze, except in very extreme cold weather. This formula is more or less accidental. When sand was being stocked, calcium chloride in sacks was taken to the commercial plant from which sand was being hauled. Two-and-a-half ton trucks happened to be used for hauling. At the plant, one sack of calcium chloride was broken open and its contents scattered over the floor of the empty dump body. The sand was then loaded by steam shovel or from storage bins, and another sack of calcium chloride was then scattered over the top of the load.

Sand so loaded and dumped into stock-piles resulted in getting a pile with the calcium chloride well enough mixed throughout the pile for all practical purposes. This mixture, averaging two sacks of calcium chloride to 2½ yds. of sand—slightly less than the ratio given above—satisfactorily prevented the stock-piles from freezing.

Loading sand onto calcium chloride first scattered into an empty dump truck facilitated dumping the loads as this prevented freezing of the sand to the bottom of the truck box when hauling in freezing weather and the dump bodies scoured easily when dumping.

It was this mixture that got onto the roads in the winter of 1925-26. In the following spring and summer and continuing into the following winter, and continuing ever since, for that matter, there has been no end of discussion among highway officials in southeastern Michigan as to the desirability of using calcium chloride because of excessive scale that began developing on some cement concrete pavements.

In any of these discussions where the writer was present, he realized two facts: first, that as a maintenance official, he was not called upon to explain any shortcomings of pavements where the defects were due to faulty construction; second, that it was his business to determine, so far as possible, if there was any possibility that continued use of calcium chloride would be really injurious enough to warrant its discontinuance.

It was a situation where any seemingly logical explanation of scale that would absolve construction from all blame would be very plausible to the construction engineer. But at the same time, the maintenance man would want to be thoroughly convinced, because a material had been discovered for use in ice removal that seemed practical, easy to handle, and whose cost was by no means prohibitive when compared to the hazards of allowing ice to remain until nature chose to remove it.

Studies of Scaling.—In the summer of 1926 the writer began seriously paying attention to the question. Places were inspected on cement concrete pavements where scale might have been caused by the use of calcium chloride. Scale was also studied at other places where the only possibility of calcium chloride ever having come in contact with the pavement was the chance that a sack of calcium chloride had fallen from a truck-load of calcium chloride in transit—and calcium chloride has never been transported in this locality by truck.

Three situations quickly presented themselves:

1. Considerable scale was noticed at places where considerable calcium chloride had been used.
2. Considerable scale was noticed at places where calcium chloride had never been used.
3. Considerable calcium chloride had been used at still other places where no appreciable scale had yet developed, or since has developed.

Three situations impossible to correlate.

These conditions actually being present on our roads could lead only to the following conclusions:

1. There was indication that in some instances there might be a relation between the use of calcium chloride and subsequent scale.
2. There were other instances where some other agent or cause was to blame.
3. There were some cement concrete pavements which did not scale under the use of calcium chloride.

It was interesting to note that in the summer of 1926 practically every place that seemed to indicate a relation between scale and the winter use of calcium chloride occurred on a new pavement—a pavement constructed in 1925. Since then other places that seem to bear out this relation almost invariably are as follows:

a. On an up-hill traffic lane on fairly steep grades;

b. At intersections protected by electric traffic semaphores and at other locations calling for the regular and sudden application of brakes on motor vehicles. At such locations scale is much more noticeable on the traffic lane leading to the signal; must less evident in the lane leading away from it. Inevitably, with heavily loaded, solid-tired trucks using skid chains, the sudden and oft repeated application of brakes over the same area of pavements results in an appallingly concentrated abrasive action upon the pavement surface.

How do we know that, considering the immense increase in motor truck transportation within the same period that calcium chloride has been used for ice removal, the same excessive scale would not have occurred had no calcium chloride ever been applied at these places?

Were such places not rendered safe in periods of ice and sleet, accidents would be unavoidable and complete tie-up of traffic would result in heavy traffic areas.

Chemists who know calcium chloride tell us that calcium chloride will not, of itself, cause scale in cement concrete pavements. Sodium chloride (common salt) does. These two chlorides possess two radically different physical properties, namely: the characteristic of sodium chloride always to crystallize and re-crystallize whenever its water of solution is evaporated, as opposed to the calcium chloride, which is always in crystalline form when dry.

Thus, a solution of sodium chloride and water soaking into the surface of a concrete pavement would carry the sodium chloride into the pores of the concrete. Upon evaporation the sodium chloride in the concrete would re-crystallize. The force of this action—exactly similar to the force exerted when ice crystals are formed from water—would have, self-evidently, anything but a beneficial effect on the concrete surface or upon the concrete below the surface.

Calcium chloride in solution on the pavement could not have this same destructive effect, however, because the possibility of obtaining the proper combination of temperature and humidity necessary to induce crystallization as the calcium chloride solution evaporated is too remote to be given consideration.

Can there be any other chemical or physical property of calcium chloride that might cause or aid scale? Would a solution of calcium chloride and water have some softening effect upon a cement concrete pavement surface that would hasten normal scaling?

Well, we know that water alone has a softening effect on some stone; possibly, also, on some mortars. Rather than calcium chloride increasing the ill effect of water alone on concrete pavements in winter-time, the writer is inclined to believe it would, in one particular, be beneficial. Fresh evidence of scale is most noticeable through open winters and in the spring. Without doubt progressive scale is greatly aided through the winter by free moisture getting between partly loosened scale and the aggregate concrete beneath, then freezing and further loosening the laitance above. Calcium chloride in this moisture would lower its freezing point and, through a winter, reduce the amount of such frost action.

Where observation found scale that could not be attributed to the use of calcium chloride it was usually on older pavements—on pavements in their third and fourth year.

Both old and new pavements were found upon which calcium chloride seemed to have no effect whatever.

Certainly nothing has come to the writer's attention

in these last five years that, in his opinion, is worthy of serious consideration from the standpoint of comparing calcium chloride's possible defects as an ice removing agent in contrast to the great benefits that are otbained by using it.

The use of calcium chloride mixed with sand has been efficient; it has given speed. Nothing better or cheaper has been developed within the writer's information. No ill effects directly traceable to calcium chloride have been seen that would lead him to change present methods. Until something better, either from the standpoint of increased speed or decreased cost without loss of speed is developed, it will be a valuable material for this work.

Pavements in this locality are built with the knowledge that the ultimate in efficient use will be demanded and extracted from them during their useful lifetime. Confronted with the task of maintaining these same pavements, most quick to protect and guard them against needless harm or injury, maintenance men have accepted calcium chloride until something better is discovered. This acceptance, in spite of the fact that they above all others realize how carefully these pavements must be conserved to produce their last ounce of public benefit, should set at rest any fears felt by construction forces whose only responsibility is to build as near the specifications involved as is practical and possible.

It is a question that maintenance authorities alone should pass upon. Theirs is the responsibility of taking care of the roads—and of the safety of the public.

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A. R. B. A. to Meet in Chicago

THE 31st annual convention and exhibit of the American Road Builders' Association will be held at the Stevens Hotel, Chicago, during the week of January 22. The association's national campaign to bring before the public the necessity for a continued highway program will be launched at this winter's convention. The campaign will stress the vital necessity for restricting the expenditure of gasoline and motor vehicle revenues to highway and street budgets. Assurances already have been received from affiliated organizations and individual members of the national association that every state in the country will be represented.

The convention will bring before the general public the demand for continued participation of the Federal government in the highway program. It is intended to show the public that there still remain 75,000 miles of state highway system roads which never have been improved and that 2,400,000 miles of "mud" roads continue to be the sole outlet for more than 3,000,000 farms. The congestion in municipal centers is proof of the need for arterial highways through such centers and for belt lines around all the larger cities.

Traffic volume increases in recent years have greatly over-taxed the old systems built to cope merely with the demands of a decade or more ago and the question of modernization and widening will be carefully studied by engineers and officials who will meet at the convention in Chicago. The plan of the association is to bring these facts forcefully before the public in general through speakers of national reputation and authority.

The National Highway Advisory Council, composed of representatives of the affiliated organizations and divisions of the American Road Builders' Association, will meet during the general convention to consider a large number of problems. These include the operation of the code covering the Highway Industry; the continued financing of the program including the source and distribution of funds; and the extent to which the Federal government should participate in future highway developments. These matters will be presented by men especially chosen by the program committee for their background in the particular subjects.

The County Highway Officials' Division and City Officials' Division will hold their special sessions as in the past. The highway contractors, who formerly were represented in the highway section, will become part of the many affiliations recently extended and will form a regular section of their own with their own officers. This has been made necessary by the ever increasing problems of the highway contractor and the demand that these problems should be met by those completely within this branch of the industry.

There will be the usual general sessions where major problems confronting the entire industry will be discussed and where several of the committee which have been operating throughout the year will present their findings.

The Road Builders' Exhibit will be held during the convention in the Exhibition Hall of the Stevens Hotel. This will be the first time in many years that the annual road show has been housed under the same roof as the convention and the idea already is proving popular.

Although the spaces are somewhat smaller than in certain other years, the exhibitor will find every facility for presenting the latest developments in his highway construction and maintenance materials and machinery to the assembled engineers, contractors and officials. This type of exhibit will prove unusually popular with the exhibitors who, in keeping with the spirit of the times, are desirous of presenting their products in the most economical manner.

A large number of spaces already have been reserved by manufacturers who are bringing out new developments in low cost roads, and a great many specializing in higher type pavements will be represented. The plan of having the road show and convention in the same building will provide a maximum of time for inspection and exhibition.

This year's convention is intended as a clearing house where all elements of the highway industry will be able to present their problems and solution and where through the combined efforts of all the highway program will be able to secure its just amount of funds for continuance.

The plan is to bring to the attention of the public with renewed vigor the benefits to be derived generally, in addition to the immediate benefit of unemployment relief, from an active highway program.

The convention and exhibit will emphasize the advantages of a continued highway program as well as the technical phases of highway development. They will serve to put before the taxpayer and the legislator the economic facts to justify increased construction and constant maintenance and the segregation of highway revenues for highway purposes.

Reduced railroad fares of one and one-third will be in force for those attending the convention and hotel reservations may be made through the hotel committee of the American Road Builders' Association, or direct.

▼

OUT OF STATE CONTRACTORS MUST SECURE PERMIT IN IOWA.—No corporation organized under the laws of any state other than Iowa is qualified to bid on primary road projects in Iowa unless satisfactory evidence has been furnished that such corporation has secured a permit to transact business in the State of Iowa.

Summary of 1933 Motor Vehicle Legislation

By Pierre Schon
Transportation Engineer, General Motors Truck Co., Pontiac, Mich.

IN the 43 state Legislatures assembled in regular session this year, several thousand bills were submitted affecting motor vehicle transport, in one way or another. The most drastic type of the proposed legislation which confronted the industry centered on:

1. Excessive taxation of trucks and busses.
2. Drastic reductions in sizes and weights.

In reviewing the results of the 1933 Legislative activities, there is little evidence available that attempts were made in any of the 43 legislatures to achieve greater uniformity in size and weight regulations between neighboring states. On the contrary, there is ample evidence available that the major part of the proposed legislation definitely intended to remove highway transport as a competitive factor to an older system of transportation. In every state legislative session powerful and well organized lobbies were extremely active in proposing and supporting so called anti-truck bills. The drastic reductions of sizes and weights as proposed in these bills were in all cases far below the standards as set up in the recommended codes.

In the July issue of the S. A. E. Journal, the code formulated jointly by the Automotive Code Committees of the Society and the American Petroleum Industry was published. There are three other codes in existence and in order to picture the situation clearly, this presentation is confined to a comparison of existing laws with the four major codes as recommended by:

1. Society of Automotive Engineers.
2. American Association of State Highway Officials.
3. National Conference on Street and Highway Safety.
*4. Bureau of Public Roads.

Width Regulations.—As portrayed in the chart, it is evident that greater progress has been made toward national uniformity in the laws prescribing a maximum width limitation than in any of the other vehicle regulations. This may be ascribed to the fact that all the existing codes have consistently recommended a standard of 96 in. During the last legislative sessions three states moved up from the lower brackets into the 96-in. group, making a total of 46 states where the 96-in. width is now legal. Only 3 states are below the 96-in. standard limit.

The advent of the balloon tires during recent years, and the need for more space to accommodate dual balloon tires, as compared with the narrower solid tire of equal carrying capacity, has resulted in slightly increasing the legal width limit in several states. Where such increase is allowed, it does not affect the width of the body nor any part of the chassis, as it applies only to the dimension from outside to outside of dual tires. Nine states allow from 100 to 106 in., and this greater width allowance tends to encourage operators to change over from solid to pneumatic tires. It also solves the clearance problems for the designing engineers coincident with the application of dual balloon tires in the larger sizes. The recommendations in the SAE code, i.e., 96-in. standard and 102 in. for dual balloon tires meets all practical requirements.

Height Regulations.—The fact that inconsistencies in code recommendations have had some influence on state legislation is beginning to show up in the height regulations. In the original so-called Hoover code, a 14½ ft. height limit was recommended. This was changed in 1930 to 12 ft. in the revision of the original code by the National Conference on Street and Highway Safety, and supported at that time by recommendations made by the U. S. Bureau of Public Roads. The American Association of State Highway Officials and the SAE codes recommend a 12½ ft. height. This means that the legislatures had 3 different height standards to choose from, and these variations in code recommendations have

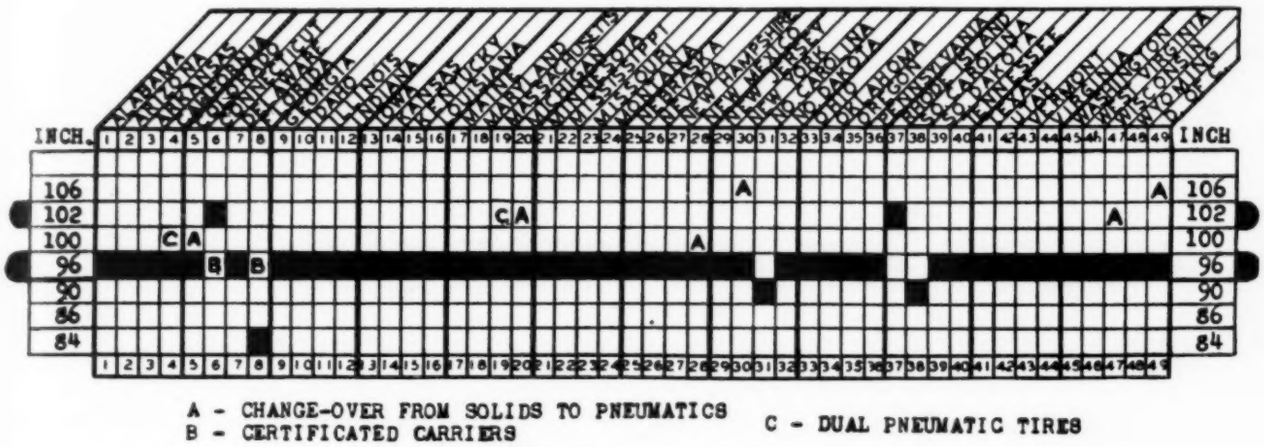
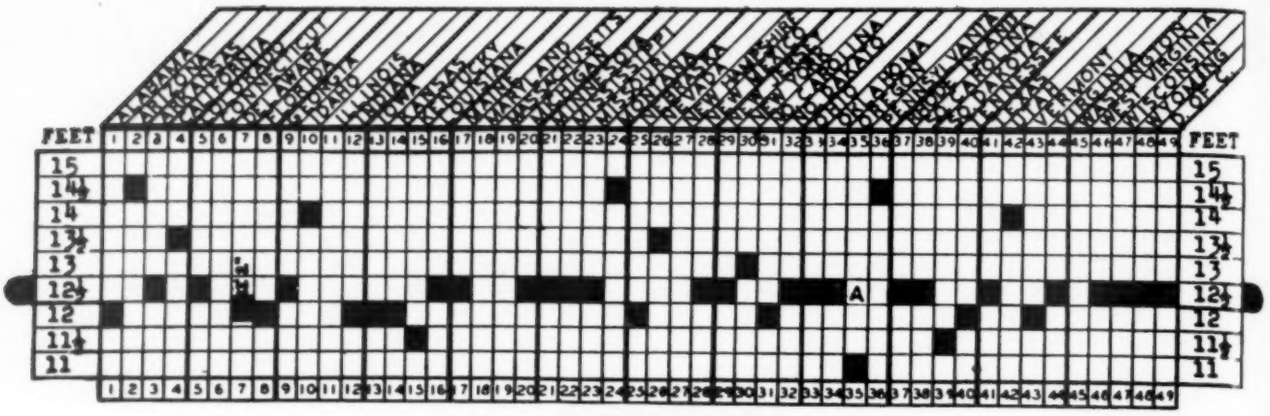


Chart Showing Width Regulations in the Various States
RECOMMENDED CODES
Society of Automotive Engineers—96 ins.-102 ins. for dual pneumatic tires.
American Assn. of State Highway Officials—96 ins. plus for tire conversions.
National Conf. on Street and Highway Safety—96 ins. plus by special permit.
U. S. Bureau of Public Roads—96 ins. plus for tire conversions.

*Recommendations as given in McDonald-Thompson paper, SAE meeting, Toronto, 10-5-32.

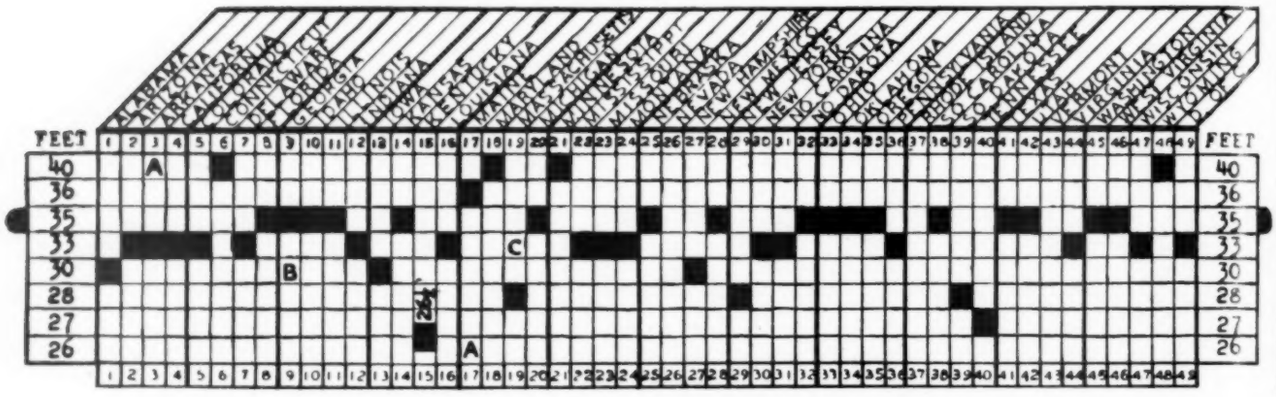


A - - BY SPECIAL PERMIT

Chart Showing Height Regulations in the Various States

RECOMMENDED CODES

Society of Automotive Engineers.....12½ ft.
American Assn. of State Highway Officials.....12½ ft.
National Conf. on Street and Highway Safety.....12 ft.
U. S. Bureau of Public Roads.....12 ft.

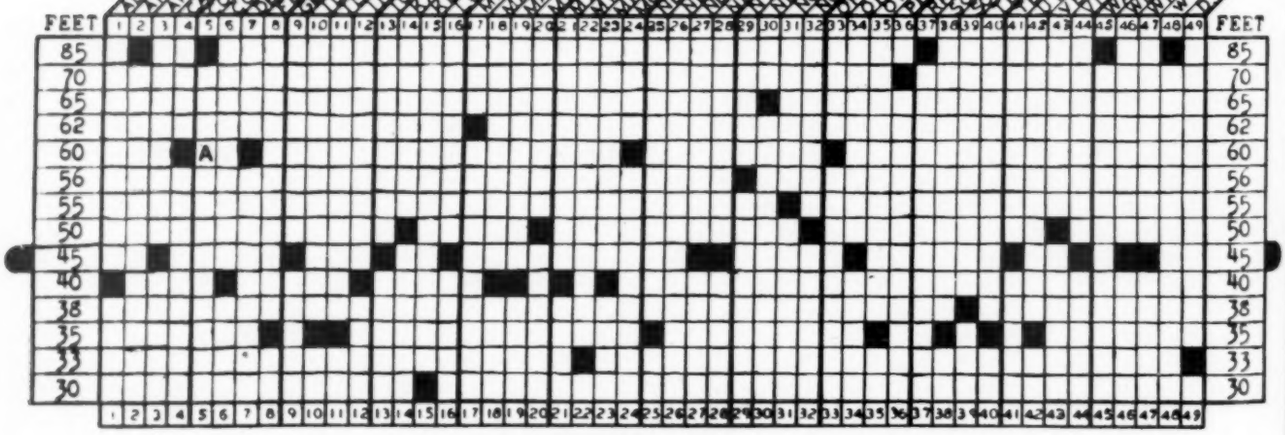


A - TRAILER OR SEMI-TRAILER C - ON WAYS DESIGNATED BY DEPT. OF PUBLIC WORKS
B - PRIVATE OPERATOR

Chart Showing Unit Length Regulations in the Various States

RECOMMENDED CODES

Society of Automotive Engineers..... 35 ft.
American Assn. of State Highway Officials..... 35 ft.
National Conf. on Street and Highway Safety..... 33 ft.
U. S. Bureau of Public Roads..... 35 ft.

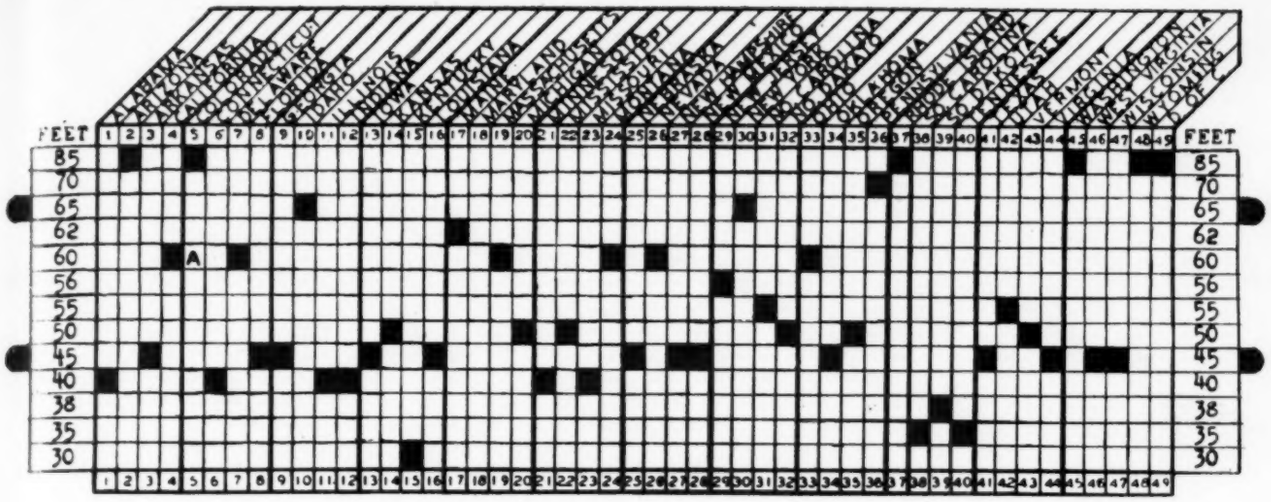


A - ON MOUNTAIN ROADS

Chart Showing Tractor Semi-Trailer Length Regulations in the Various States

RECOMMENDED CODES

Society of Automotive Engineers..... 45 ft. 2 units
American Assn. of State Highway Officials..... 35 ft. 1 unit
National Conf. on Street and Highway Safety.... 85 ft. 2 units
U. S. Bureau of Public Roads..... 65 ft. 2 units



A - ON MOUNTAIN ROADS

Chart Showing Combination Length Regulations in the Various States

RECOMMENDED CODES

Society of Automotive Engineers.....
....45 ft. on roads 20 ft. or less; 65 ft. on roads over 20 ft. wide
American Assn. of State Highway Officials..... 45 ft.
National Conf. on Street and Highway Safety..... 85 ft.
U. S. Bureau of Public Roads..... 65 ft.

resulted in 3 major groups of height regulations, i.e.:

6 states have no restrictions.
8 states allow *more* than 12½ ft.
22 states allow 12½ ft.
13 states allow *less* than 12½ ft.

The 12½ ft. group of states is in the majority. Seven states have adopted this standard in the last Legislative sessions.

It is reasonable to assume that unformity of code recommendations will be a highly important factor in eventually obtaining uniformity in legislation.

Single Unit Length Regulations.—Again there is evidence in this tabulation that code recommendations influence legislation. A 33 ft. standard length was recommended in the older codes, but the more recent codes recommend a 35 ft. length.

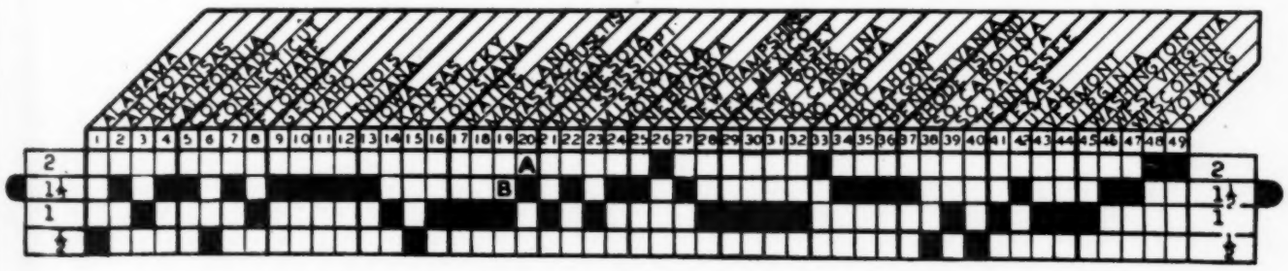
3 states have no restrictions.
5 states allow *more* than 35 ft.
17 states allow 35 ft.
16 states allow 33 ft.
8 states allow *less* than 33 ft.

In classifying these regulations into 2 groups, we find 25 states where the 35 ft. standard length is legal now, while the laws in 24 states restrict vehicle lengths to less than 35 ft.

While there was very little evidence of opposition in the legislative halls to the 96-in. width and 12½-ft. height limitations, anti-truck propagandists and lobbyists proposed radical reductions in the lengths and weights in most of the 43 state legislatures. The recommendations of the anti-truck group proposed single unit length limitations ranging from 26 ft. to 30 ft.

Length Regulations for Tractor Semi-Trailer Combinations.—At this point we find a wide difference in existing regulations, and also no similarity in the code recommendations.

The first question to be clarified relates to the classification of this type of vehicle combination as one unit, or shall a tractor semi-trailer be classed as a combination of two vehicles. It is obvious that the one-unit classification leads into registration, license and tax complications, due to the fact that in general practice the tractor itself



A - UNTIL 1936 B - BY PERMIT

2 - 2 REGULAR TRAILERS
1½ - 1 SEMI-TRAILER AND 1 TRAILER
1 - 1 SEMI OR 1 TRAILER
½ - 1 SEMI-TRAILER ONLY

Chart Showing Number of Trailer Regulations in the Various States

RECOMMENDED CODES

Society of Automotive Engineers....1½ or 2 load carrying units
American Assn. of State Highway Officials.....Not specified
National Conf. on Street and Highway Safety.....Not specified
U. S. Bureau of Public Roads.....1½ or 2 load carrying units

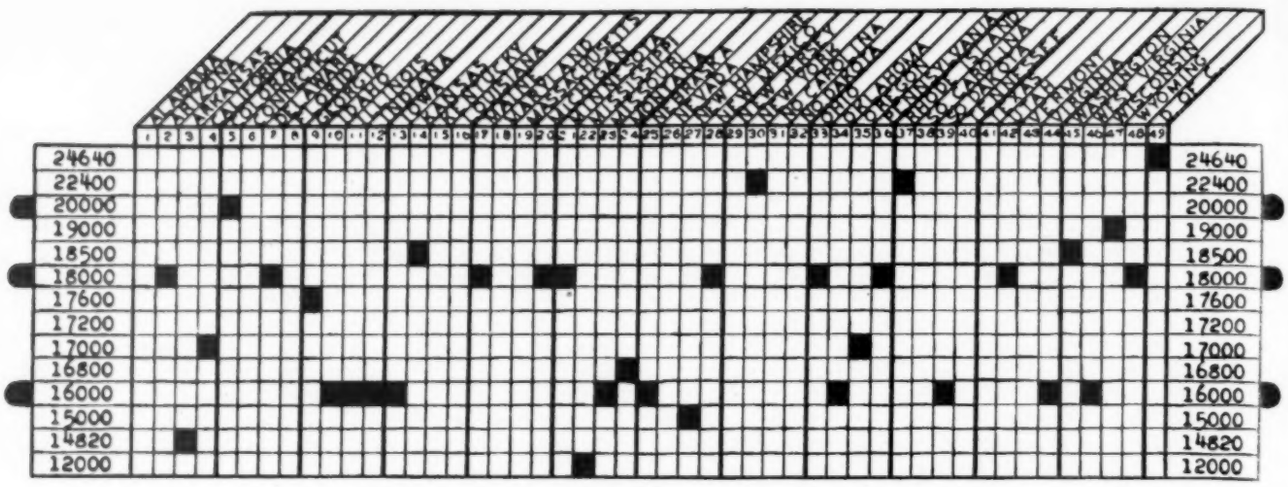


Chart Showing Single Axle Weight Regulations in the Various States

Maximum Axle Weights for Pneumatic Tired 4-Wheel Trucks Operating on Major State Highways Without Consideration to Exceptions for:

1. Reductions for solid or high pressure pneumatic tires.
2. Regulations controlling weight for tandem axles.
3. Deductions for secondary rural roads.
4. Reductions through seasonal restrictions.
5. Increase for metropolitan areas or city streets.

is not permanently coupled to one semi-trailer, and may be frequenly switched from one semi to another.

The 35 ft. length applying to the single vehicle is also highly desirable for the semi-trailer itself in hauling bulky commodities. The tractor drawing the semi-trailer requires a minimum length of 10 ft. ahead of the semi-trailer, resulting in an over-all practical length of not less than 45 ft. for this combination of two vehicles.

While the maximum length for other combinations still applies to the tractor semi-trailer in many states, the grouping according to existing regulations, including new laws effective as of January 1, 1934, shows the following variations:

1 state has no regulations.
18 states allow *more* than 45 ft.
11 states allow standard 45 ft.
19 states allow *less* than 45 ft.

The 45 ft. length limitation is legal in 30 states. In the last legislative sessions, several states adopted the 45 ft. length, while in other states new regulations reduced the limitations below this standard. The SAE code recommendations are based on practical design limitations and operating requirements.

Single vehicle length—35 ft.

Tractor semi-trailer length—45 ft. and considered as units.

Length Regulations for Combinations of Vehicles.—This part of the regulations has been a highly controversial subject in the state legislatures during recent years. Long vehicle trains hugging the center of the pavement on narrow, congested highways have largely contributed in creating adverse public opinion against truck transportation in general, resulting in some drastic legislation in several states and threatening to further curtail the permissible length dimensions in future legislative sessions.

That extreme combination lengths are objectionable on narrow pavements to other highway users is an established fact, but it is generally conceded that on pavements with more than two traffic lanes, there is no difficulty encountered in passing a combination of vehicles. This means that a standard uniform national code should differentiate in the length recommendations for narrow roads as compared with 3-, 4-, 6- and 8-lane superhighways. This is not given any consideration in 3 of the codes, while the SAE code recommends a 45 ft. length for highways 20 ft. or less in width, and a 65 ft. length for highways wider than 20 ft. This recommendation is based on the fact that standard pavements wider than 20 ft. have more than two traffic lanes, as it is common practice to build pavement traffic lanes in one of three standard widths, i.e., eight, nine or ten feet. It is obvious, therefore, that any standard pavement wider than 20 ft. has 3 traffic lanes, or a total overall width of 24, 27 or 30 ft. Regulations effective now or by next Jan. 1st, are grouped as follows:

1 state has no regulations.
25 states allow *more* than 45 ft.
13 states have adopted the 45 ft. standard.
10 states allow *less* than 45 ft.

Vehicle combinations 45 ft. in length are legal in 39 states, and while a 60 ft. overall length is permitted in 16 states, the 65 ft. limit is legal in only 9 states. A further study of code recommendations seems highly desirable in order to pave the way for national uniformity of regulations.

Number of Trailers.—In the majority of states, the legal regulations permit two load carrying units, i.e., a semi-trailer plus one regular trailer, or a regular truck and 1 trailer. Public opinion has been influential in the enactment of this part of the regulations for the same reasons as outlined in regard to combination lengths.

Inclusive of new laws effective as of Jan. 1st, 1934, present regulations stand as follows:

4 states allow 2 full trailers drawn by a truck.
21 states allow 1 trailer *and* 1 semi.
10 states allow 1 trailer *or* 1 semi.
5 states allow 1 semi-trailer only.

Code recommendations are confusing to the legislator and clarification is needed. While the recommendations for 2 of the codes are based on a minimum maximum of 2 units in a combination, the ultimate maximum perhaps should be definitely recommended on the basis of allowing a tractor semi-trailer combination to draw 1 trailer, the standard now legal in 25 states.

Weight Regulations, Single Axle Weight.—The problem of weight regulations, based on experience in the last legislative sessions, is without a doubt the most con-

RECOMMENDED CODES

Classified Highways	Tire Types	Society of Automotive Engineers	Am. Assn. of State Highway Officials	Nat. Conf. on St. and Highway Safety	U. S. Bureau of Public Roads
Metropolitan Areas and City Streets..	Solids	22,500	Not Specified	22,400	Not Specified
	High press. pneu.	22,500		22,400	
	Balloon	22,500		22,400	
Major Highway	Solids	Eliminate	Not Specified	14,400	Not Specified
	High press. pneu.	18,000		18,000	
	Balloon	20,000		Not Specified	
Secondary Highway, Any Roads.....	Solids	Eliminate	Not Specified	8,000	Not Specified
	High press. pneu.	16,000	16,000	16,000	16,000
	Balloon	18,000	18,000	Not Specified	18,000

troversial of all the issues. Strenuous efforts were made in most states by interstate opposed to the development of highway transportation to enact laws calling for most stringent weight regulations and restricting the use of trucks to only the lighter types of vehicles.

It is apparent from the chart that a wide variation exists in allowable axle loads.

15 states have not enacted axle weight regulations.
7 states allow weights in excess of 18,000 lbs.
10 states held to 18,000 lbs.
4 states permit weights between 16,000 and 18,000 lbs.
10 states prescribe 16,000 lbs.
3 states restrict to less than 16,000 lbs.

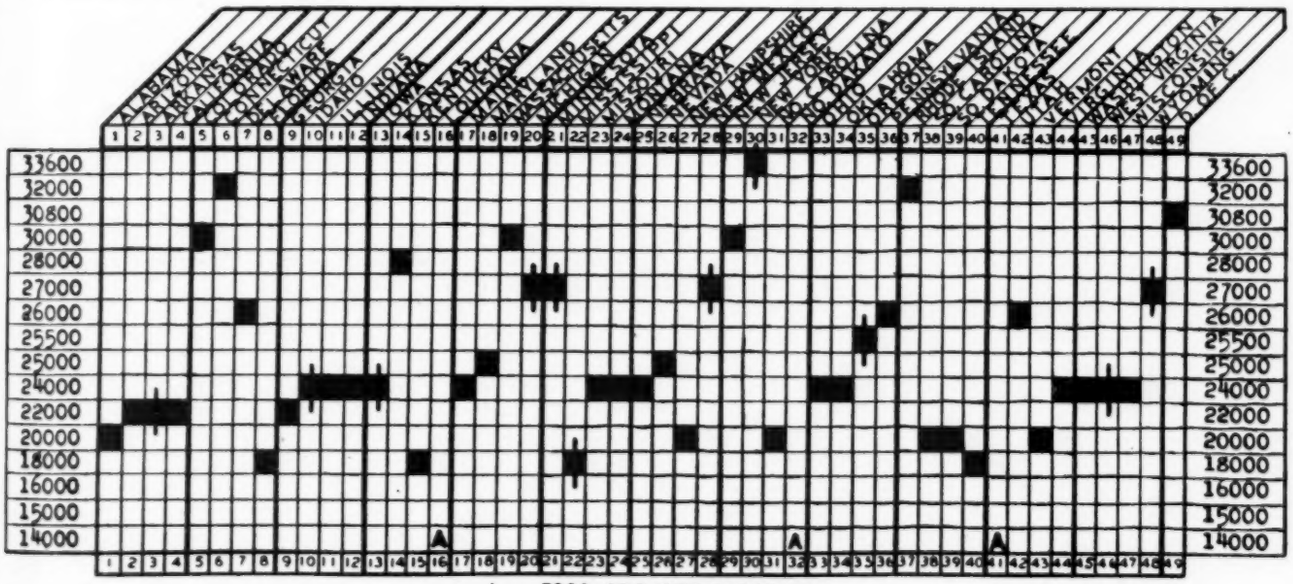
In the 15 states where no axle weight limitations are in effect, the gross vehicle weight regulations is the controlling factor.

Code recommendations for single axle weights vary considerably. Two of the codes recommend 16,000 lbs. for high pressure pneumatic tires and 18,000 lbs. balloon tires as standards for all highways. It is clearly evident that in these two codes highway engineers intended to protect the poorest pavements and the weakest bridges in a state highway system. In the codes formulated by the SAE and the Safety Conference greater weights are recommended for city streets in metropolitan areas. The SAE code also recommends a more liberal axle weight allowance for balloon tires on major highways.

Regardless of the fact that the 4 codes recommend axle weights as the basis for controlling the weight of vehicles, there is tendency in the legislatures to enact gross vehicle weights or in some cases net payload as evidenced in tabulation showing 4-wheel truck gross weight limitations.

A further study of axle weight regulations by these 4 groups is necessary in order to reconcile code recommendations on a more uniform basis. Unless a definite unified program can be submitted, enactment of uniform laws can hardly be expected to originate from future legislative sessions.

Effect of Legal Regulations on Design and Operating Practice.—The reductions which have been made in the permissible length of vehicles and combinations of vehicles, together with the weight reductions are gradually creating a demand from the operators for conservation of economical load space and utilization of maximum payload capacity. This trend has brought our industry on the threshold of reverting to the design commonly used during the early days of the truck in-



A - 7000 LBS NET PAYLOAD

GROSS WEIGHT COMPUTED ON BASIS OF MAXIMUM LEGAL AXLE WEIGHT. PLUS 50% THEREOF FOR FRONT AXLE WEIGHT.

Chart Showing 4-Wheel Truck Gross Weight Regulations in the Various States

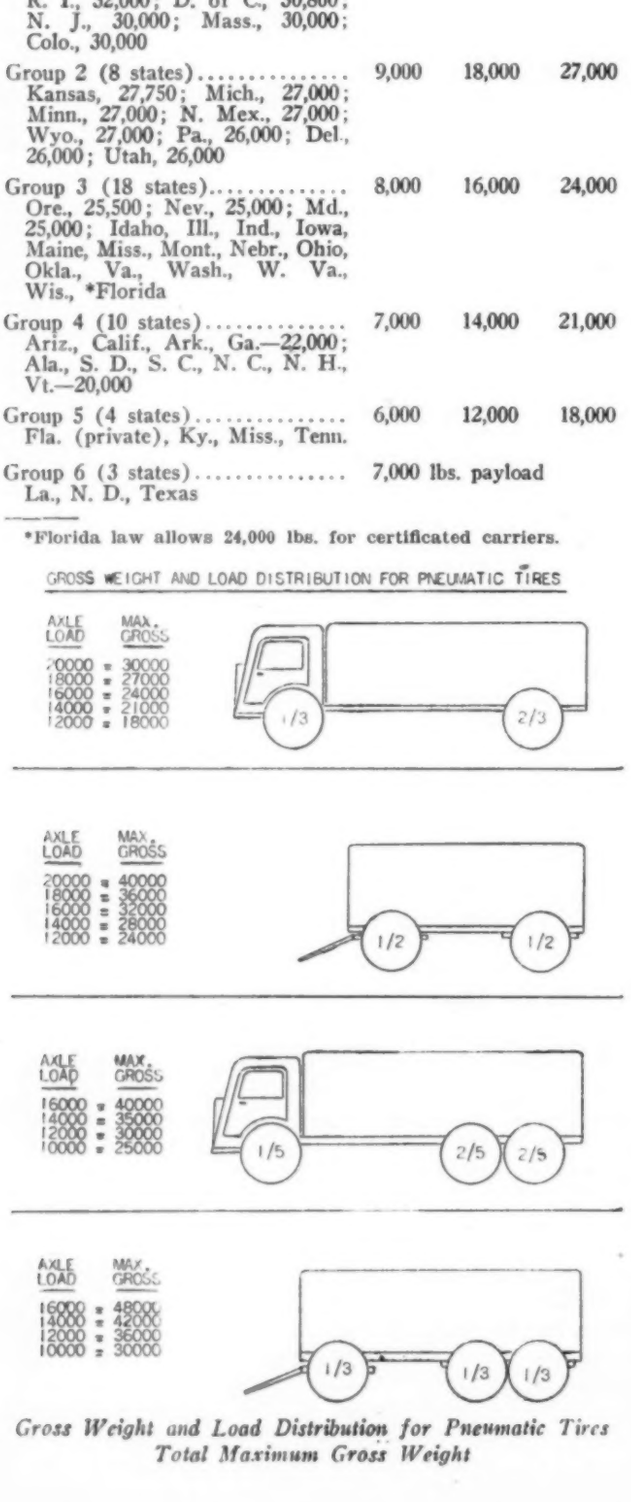
For example:
Michigan has no gross vehicle weight restrictions.
Maximum legal rear axle weight..... 18,000 lbs.
Practical front axle weight ..... 9,000 lbs.
Total gross vehicle weight ..... 27,000 lbs.

dustry when it was a general practice to build the driver's cab over the engine. Such a truck requires several major design changes, the most important of which is an increase in the front axle load capacity, permitting a load distribution of one-third of the gross vehicle weight at the front wheels and two-thirds at the rear wheels.

Under present existing legal weight regulations, all states may be classified by groups with legal axle weights and legal gross vehicle weights as follows:

	Approx. Front Axle Weight	Approx. Rear Axle Weight	Total Gross Weight
Group 1 (7 states)..... New York, 33,600; Conn., 32,000; R. I., 32,000; D. of C., 30,800; N. J., 30,000; Mass., 30,000; Colo., 30,000	10,500	21,000	31,500
Group 2 (8 states)..... Kansas, 27,750; Mich., 27,000; Minn., 27,000; N. Mex., 27,000; Wyo., 27,000; Pa., 26,000; Del., 26,000; Utah, 26,000	9,000	18,000	27,000
Group 3 (18 states)..... Ore., 25,500; Nev., 25,000; Md., 25,000; Idaho, Ill., Ind., Iowa, Maine, Miss., Mont., Nebr., Ohio, Okla., Va., Wash., W. Va., Wis., *Florida	8,000	16,000	24,000
Group 4 (10 states)..... Ariz., Calif., Ark., Ga.—22,000; Ala., S. D., S. C., N. C., N. H., Vt.—20,000	7,000	14,000	21,000
Group 5 (4 states)..... Fla. (private), Ky., Miss., Tenn.	6,000	12,000	18,000
Group 6 (3 states)..... La., N. D., Texas	7,000 lbs. payload		

*Florida law allows 24,000 lbs. for certificated carriers.



Gross Weight and Load Distribution for Pneumatic Tires Total Maximum Gross Weight

THE U. S. BUREAU OF PUBLIC ROADS L PLUS 40 FORMULA

As recommended by the Bureau:

W = total gross weight, with load, in pounds
C = a coefficient to be determined by the individual states
L = the distance between the first and last axles of a vehicle or combination of vehicles, in feet

As enacted in the State Legislatures:

$$W = \frac{C}{450} \times L + 53\tfrac{1}{2}$$
$$W = 500 \times L + 40$$
$$W = 600 \times L + 40$$
$$W = 650 \times L + 40$$
$$W = 670 \times L + 40$$
$$W = 750 \times L + 40$$
$$W = 800 \times L + 40$$
$$W = 1{,}000 \times L + 40$$
$$W = 1{,}330 \times L + 40$$

While 4 states specify a coefficient of 600, in each of these 4 states L varies from the other three resulting in 4 different gross weight limits even where "C" happens to be the same

From a comparison of the formula with practical axle loads and total gross weight for a 4-wheel truck and a 4-wheel trailer combination it is apparent that a simpler method must be devised to establish a sound basis for uniform gross weight regulations.

Asknowledgment.—The foregoing is a paper presented at the International Automotive Engineering Congress of the Society of Automotive Engineers at the Palmer House, Chicago, Ill., August 28 to September 4, 1933.

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Traffic Line Practice in Great Britain

A report in the use of traffic lines on highways in Great Britain has been issued recently by the British Ministry of Transport Advisory Committee on experimental Work. The report is based on replies to a questionnaire sent to all highway authorities who have had experience with traffic lines. The conclusions given in the report follow:

1. The width of inset lines almost always 4 in., and of painted lines 4 in., or less commonly, 6 in.

2. The choice between continuous and broken lines is governed primarily by considerations of economy and ease of laying rather than by the attachment of any particular significance to either type.

3. There is little difference in cost and efficiency between continuous and broken painted lines, but when inset materials are used broken lines are cheaper and equally satisfactory. The Departmental Committee has, however, recommended that a full line should be used when a definite warning is called for, and discontinuous lines for other purposes.

4. Painted lines are satisfactory and are extensively used in districts where the traffic is light, but are of little permanent use where the traffic is heavy.

5. No information is available regarding variations of practice in applying painted lines on different types of road surface.

6. The average cost of painted lines is 6 ct. to 12 ct. per lineal yard per application.

7. The choice between white and yellow painted lines appears to be entirely a question of personal preference.

8. There is general agreement as to the suitability of stainless steel for providing permanent lines on all types of road surface, particularly those carrying heavy traffic, with the possible exception of tar macadam.

9. Aluminum inset materials are satisfactory except where the traffic is very heavy.

10. Brass studs have been used in only a few cases, but the results appear to be satisfactory and to justify further trial.

11. The results obtained with non-metallic inset materials appear to justify further trial.

CROMANSIL STEELS

A New Alloy Steel for Bridges

IMPROVED materials and improved methods are effecting widespread advances in the fabrication and erection of steel structures. New formulas for alloy steels for bridge building will make for longer spans having greater strength with less weight than what has been possible in the past. "Cromansil" steel, which is a steel alloy of chromium, manganese, silicon and iron, is one of these. It was first developed in 1929, and, following extensive tests, was put on the market in 1930. Today "Cromansil" steel is being accepted rapidly by engineers for special structures and is now being introduced to bridge designers.

In view of the growing importance of alloy structural steels, the American Institute of Steel Construction, at its Eleventh Annual Convention at the Stevens Hotel, on Oct. 9, listened to a paper prepared and read by W. B. Miller, consulting engineer of the Union Carbide and Carbon Research Laboratories, Inc., describing the properties and uses of this new material. An abstract of his paper follows:

As the name implies, Cromansil steels derive their superior physical properties from the elements chromium, manganese and silicon, together with varying carbon contents, depending on the physical properties desired and the intended use of the steel. While for special applications somewhat different ranges are specified, the more useful compositions will fall within the following range of alloy metal content:

	Per Cent
Chromium	0.4-0.6
Manganese	0.9-1.2
Silicon	0.7-0.9

The carbon content can be varied widely, the amount depending on the use to be made of the steel. The following carbon range is indicated for some typical applications:

	Per Cent
Staybolt	Not over 0.10
Rivets	Not over 0.20
Boilers, pressure vessels, structural	Not over 0.15-0.22
High strength seamless tubing	Not over 0.30-0.35
Heat treated parts	Not over 0.35-0.65

Physical Properties.—The physical properties of typical Cromansil steels are summarized in Table I.

In summing up the properties of Cromansil steels we may state: (1) That Cromansil steels afford the maximum benefit of alloy content at a lower cost than any other alloy combination so far marketed; (2) the benefits are usually derived when material is in the rolled condition; (3) the transverse and shearing strengths are very high for any tensile strength; (4) desired properties may be obtained without heat treatment by selection of appropriate alloy and carbon percentages; (5) Cromansil steels greatly extend the tensile ranges for certain structural requirements at reasonable costs without proportionate sacrifice of ductility; (6) the fatigue limit of Cromansil steels is about 60% of the ultimate strength. Cromansil staybolts with an ultimate strength of 68,000 psi. have a fatigue limit of 42,000 psi.; (7) by comparatively simple heat treatment Cromansil steel has a better combination of strength and ductility than any form of carbon steel. With tensile strengths around 140,000 psi. these steels have an impact value of from 14 to 22 ft. lb. Izod.

Working Properties.—The manufacture of Cromansil steel requires no special or unusual metallurgical pro-

PHYSICAL PROPERTIES OF TYPICAL CROMANSIL STEELS AS ROLLED OR NORMALIZED

Type of Material	Analysis (Per Cent) C	Cr	Mn	Si	Condition	Yield Point (Thousands of Lb. per Sq. In.)	Ultimate (Thousands of Lb. per Sq. In.)	Elongation (Per Cent in 8 Inches)	Reduction in Area (Per Cent)	Izod	Brinell
Staybolts (1-in. round)	0.05	0.25	1.12	0.87	As rolled	54	71	31	75	64	125-135
Boiler plate	0.21	0.47	1.17	0.72	.....	..	..	..	..	..	.....
½-in. Plate:											
Longitudinal	...	...	...	...	As rolled	50	92	20	56	36	200-220
Transverse	...	...	...	...	As rolled	51	91	18	54	..	.....
1-in. Plate:											
Longitudinal	...	...	...	...	As rolled	51	99	16	..	..	200-220
Transverse	...	...	...	...	As rolled	51	98	14	..	25	.....
1½-in. Plate:											
Longitudinal	...	...	...	...	As rolled	56	89	19	..	..	200-220
Transverse	...	...	...	...	As rolled	53	89	17	..	24	.....
2-in. Plate:											
Longitudinal	...	...	...	...	As rolled	53	86	20	..	..	200-220
Transverse	...	...	...	...	As rolled	54	88	15	..	20	.....
½-in. plate	0.21	0.51	1.09	0.64	Normalized	53	94	20	..	..	200-220
⅜-in. plate	0.22	0.43	1.15	0.87	Normalized	74	105	29*	50	32	210-230
Structural Shapes:											
2x2-in. bar	0.32	0.46	1.07	0.44	As rolled	..	..	..	..	..	.....
Center	...	...	...	...	.....	65	99	27*	64	..	200-220
Edge	...	...	...	...	.....	68	107	25*	62	..	.....
¼-in. plate	0.31	0.42	1.13	0.87	As rolled	72	119	23*	..	42	225-245
⅛-in. Plate:											
Longitudinal	0.46	0.67	1.19	0.82	As rolled	88	142	20*	..	..	265-285
Transverse	...	...	...	...	As rolled	91	143	19*	..	20	.....
Longitudinal	...	...	...	...	Normalized	100	148	20*	..	..	.....
Transverse	...	...	...	...	Normalized	101	140	20*	..	23	.....

*Results marked * are per cent in 2 inches.

cedure. It can be made readily in the open hearth at a nominal increase in cost over carbon steel. From experience we know that Cromansil steel rolls well and can be fabricated into any structural shape. Forging is easily done and no fundamental change from carbon steel practice is required. An instance of its easy workability is the piercing and drawing of billets to seamless tubing.

Although these steels are extensively used in the as rolled condition, they lend themselves to inexpensive heat treatment on account of their excellent normalizing characteristics.

Fabrication and Shop Use.—Fabrication of structures and working with all ordinary shop tools, including threading and welding equipment, are not essentially different with Cromansil than with ordinary carbon steel. These operations require no extra tooling and can be carried out with no increase in cost over that required for carbon steel. One-half inch plate can be bent flat on itself without fracture. Local heating for hot bending does no damage to the structure. Hence the use of this steel by the designer does not involve any unusual shop practice or additional expense either in machining or fabrication. Wherever selection of Cromansil is indicated the slight increase in cost is justified by the increased physical properties and no allowance need be made for increased fabricating cost.

Let us now consider somewhat in detail what results may be expected from the fabrication operations of welding, flame cutting, and riveting.

Welding.—The welding of plate, pipe and other Cromansil shapes can be done with the usual equipment. The steels commonly used for welding will be the 0.10 per cent and 0.20 per cent carbon grades of approximately 75,000 and 95,000 psi. ultimate strength respectively. These grades will contain chromium 0.4 to 0.6 per cent, manganese 0.9 to 1.2 per cent, and silicon 0.7 to 0.9 per cent. Both the 0.10 and 0.20 per cent carbon grades ⅜ in. thick can be welded by the oxyacetylene process with high strength rods, producing welds of plate strength and having bend elongations of 20-40 per cent. With heavier thicknesses in the 0.20 per cent carbon grade a special high strength rod is required. This is due to the fact that less benefit of the alloys in the plate is obtained in the heavier welds. Thus with good welding practice oxyacetylene welds with ultimate strengths of 75,000 to 95,000 psi can be obtained depending on the grade of Cromansil being welded. If welds are made in grades containing more than approximately 0.20 per cent carbon, a normalizing treatment is necessary to insure adequate ductility in the welded joint.

Arc welding with its more rapid heating and cooling will be more liable to produce a slight air hardening effect in the high tensile steels than will oxyacetylene welding. However, this is no obstacle to the use of arc welded Cromansil structures for the reason that in modern practice the metal is deposited in multiple layers and an annealing effect is thus obtained on each preceding layer or layers.

The following table summarizes the results obtainable in welds in 0.20 per cent carbon Cromansil steel, depending on thickness of material, design of joint, and choice of electrode, the higher strengths being realized with alloy steel electrodes.

	Weld Position		
	Flat	Vertical	Overhead
Yield point, psi	58-63,000	56-61,000	56-61,000
Ultimate strength, psi	86-98,000	86-96,000	86-92,000
Per cent bend elongation	20-35	20-30	20-30
Brinell hardness—Plate		180-200	
Brinell—Heat affected zone		230 max.	
Brinell—Weld metal		260 max.	

The minimum ductility obtained in any case is higher than that realized in most steel structures welded with bare electrodes and which are performing quite satisfactorily.

Flame Cutting.—Cromansil steels are readily cut with the oxyacetylene cutting torch leaving exceptionally clean surfaces and smooth corners. It is well known that flame cutting of most high strength steels usually results in a surface hardening that is ordinarily prevented by preheating to a black heat before cutting. Tests indicate that Cromansil steel is less susceptible to this hardening effect than other steels of like physical properties. Likewise it does not seem to have pronounced hardening properties during welding. The writer believes that this lesser susceptibility to skin hardening is due to the low heat conductivity of Cromansil steel,—about one-third that of ordinary boiler plate. The relatively low carbon content in Cromansil is also a factor. This property works to good advantage during welding and flame cutting in that the cold base metal cannot extract heat fast enough to produce the maximum hardening effect as in other steels.

Riveting.—In order to take advantage of the high strength of Cromansil steels in riveted structures a high tensile rivet is required that will lend itself to all the usual operations. Such a rivet has been developed in the Union Carbide and Carbon Research Laboratories and consists of a low carbon Cromansil steel of exceptional strength and ductility. Through the courtesy of Mr. A. E. Gibson, Vice-President, the Wellman Engineering Company, we have obtained some exceedingly interesting data on rivet tests in Cromansil steel using Cromansil rivets. The tests were carried out on 0.22 per cent carbon Cromansil having an elastic limit of 63,000 psi, and an ultimate strength of 92,000 psi. Two types of rivets were used; viz., 0.10 per cent carbon and 0.19 per cent carbon, having the following physical properties:

	Type SN7	Type SN8
Carbon, per cent	0.105	0.19
Silicon, per cent	0.68	0.60
Manganese, per cent	1.17	1.10
Chromium, per cent	0.38	0.30
Elastic limit, psi	68,000	72,500
Tensile strength, psi	77,000	89,500
Elongation in 2 in., per cent	37	32
Reduction area, per cent	77	71.4
Hardness, Brinell	151	163

Tests on ¾ in. single rivets in single and double shear gave the following values:

	Shearing Load—Lb.	Shearing Load—psi
Single Shear		
SN7 (av. of 5 tests)	40,400	78,000
SN8 (av. of 4 tests)	54,500	105,100
Double Shear		
SN7 (av. of 5 tests)	76,300	73,600
SN8 (av. of 5 tests)	100,100	97,100

Pure shear tests were carried out on a driven and an undriven rivet of SN8 showing:

63,620 psi for undriven,
112,200 psi for driven rivet.

Tensile tests on driven rivets showed ultimate strengths of over 124,000 psi for the SN7 and over 135,000 psi for the SN8 type.

From the foregoing it is seen that a remarkable increase in strength from 77,000 psi to over 135,000 psi has resulted from the heating of the rivet, the quick cooling from contact with cold metal and the working of the steel in the riveting operation.

This excellent experimental work by Mr. Gibson leaves no doubt as to the value of Cromansil steel for high tensile rivet stock. Furthermore, Cromansil rivets do not develop the brittleness so often encountered with

the high manganese rivet and may be readily chipped where flat head rivets flush with the plate are desired.

Pure shear tests, made in the Union Carbide and Carbon Research Laboratories on the SN7 and SN8 compositions gave the following values: the ¾ in. round bars were machined to ½ in. round to conform to the capacity of the testing machine.

	——Tensile Values——		
	Yield Point	Ultimate Strength	Shear Values Shear Strength
SN7	58,500 psi	75,200 psi	56,400 psi
	59,200 psi	75,200 psi	57,500 psi
SN8	61,000 psi	88,000 psi	63,200 psi
	59,300 psi	87,900 psi	69,000 psi

From these data it would appear that the yield point in the tensile test for practical purposes may be taken as a measure of the pure shear value of Cromansil rivet stock. However, these values are greatly increased by the riveting operation as mentioned before.

Another very interesting test of riveted joints in Cromansil steel plates was carried out at Lehigh University, the plates being furnished by the Lukens Steel Co., and the rivets by the Electro Metallurgical Co. Two lap and two butt joints were fabricated by the Downingtown Iron Works, one of each being made with the air hammer, the other with hydraulic pressure. The plates were ⅝ in. thick and 12 in. wide. The rivets were of Cromansil composition. Three rows of rivets were used in each case making nine rivets in a single shear in the lap joint, and eighteen rivets in double shear in the butt joint. Both butt joints failed in the main plate at a section through the outer row of rivets at stresses of 106,000 and 106,500 psi on the net section of the plate.

Both of the lap joints failed in the rivets at stresses in single shear of the rivets of 67,000 psi for the air hammer joint, and 78,200 psi for the hydraulic joint. The stress in the plate at failure was 83,000 psi, and 97,000 psi respectively for the air hammer and hydraulic joints.

Thus Cromansil plate and Cromansil rivets enable one to realize riveted joints of the highest strength, quality, and efficiency.

The exceptional high shearing strength of Cromansil steel explains its remarkable performance in deep oil well casings, for which several thousand tons have been used, and indicates its use for other threaded members subjected to heavy stresses.

In the foregoing we have endeavored to give you a general view of what Cromansil steels are, their properties, and what results may be expected of joints made by the various mechanical and welding processes. The use of high tensile steels in structures such as bridges, pressure vessels, etc., is not new. We believe that Cromansil steel affords the best low cost high strength structural steel on the market, whether it be used for welding or riveting, and should be indicated wherever saving in weight can be realized by the increased strength (almost double) over ordinary carbon steel,—a saving obtainable at a nominal increase in cost.

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Four Major Subjects to Be Emphasized at A. R. B. A. Convention

Highways are leading the Public Works Program for National Recovery. This fact will have an important bearing on the coming convention of the American Road Builders' Association which will be held in Chicago, during the week of Jan. 22, 1934. In connection with the convention the association will hold an exhibit of highway equipment and materials.

In announcing the convention date and location, H. C. Whitehurst, engineer of highways of the District of Columbia and president of the American Road Builders' Association, emphasized the four major subjects that will engage the attention of the convention. They are:

The Need for Continuation of an Adequate Highway Program.

The Necessity for Federal Participation in the Nation's Road Program.

The Use of Highway Revenues for the Extension and Improvement of the Nation's Highway Network.

The Necessity for Bringing Back to the Highway Program Gasoline and Motor License Revenues which, During the Period of Economic Stress, Have Been Diverted to Other Purposes.

Mr. Whitehurst pointed out the necessity of coordinated action to stop the inroads upon highway funds. "Unless checked," he said, "the diversion of gasoline taxes and motor vehicle license fees to other than highway purposes constitutes a serious threat to a continued highway program. These diversion tendencies must be dealt with in a positive manner; otherwise the entire highway program may collapse. This must not occur, as the highway program plays too important a part in our national life today."

The Nation's highway development in the past three years—in spite of the $400,000,000 emergency Public Works road program—has fallen below a standard that gives reasonable assurance of meeting the needs of motor transportation. Diversion of motor revenues in many of the states, of an amount estimated at $200,000,000 this year, has cut tremendously into the road programs of these political subdivisions.

It is the contention of Federal and State officials identified with highway endeavor that this sum, spent for the purpose which alone justifies its collection from motorists, would have accomplished a two-fold purpose. In the first place, they maintain, it would have meant the improvement and extension of the highway network in consonance with an extreme traffic need while, at the same time, it would have provided employment for tens of thousands of men, accomplishing more in the way of direct relief than has been achieved by applying it indirectly.

The convention, which will be the 31st annual meeting of the Association, will bring together Federal, State, City and County Engineers and Officials; equipment manufacturers; material producers; highway contractors; and others identified with and interested in sound highway development.

The exhibit to be held in connection with the convention will afford a medium for exchange of ideas as to highway equipment and material needs, and the latest improvements and developments in equipment, materials and methods.

Highway affairs will have the center of the national stage during the convention week. The general public, as well as the industry will be afforded the opportunity to become acquainted with current highway facts. They can then better determine the proper future highway course for the general welfare.

This meeting is the outstanding national event of the year in the highway industry and assumes even greater importance than ever at this time because of the relation of highways in the National Recovery Program.

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AN ENGINEERS' CITY COUNCIL.—Five members of the new City Council of Cuyahoga Falls, O., are engineers.

EDITORIALS

Contractors Will Be Affected by Currency Inflation

FOR more than a month the federal government has been bidding up the price of gold, in the belief that commodity prices would rise as fast as the price of gold rises. Had this belief been justified average commodity prices would now be back to the price level of 1926, whereas they are far below it. As a matter of fact there has been almost no change in the commodity price level during the time that the government has been trying to force prices higher by bidding up gold. In our November issue we predicted that this would be the result. We believe that depreciating the currency dollar in terms of gold will continue to have no effect upon average commodity prices or wages. This belief is based on the fact it is not the price of gold but the number of currency dollars and their velocity of circulation that determines wage levels, as was first shown statistically in "ENGINEERING AND CONTRACTING," Aug. 31, 1921. Average prices vary directly as average wages and inversely as the output per worker. Since none of these factors is altered by changing the price of gold in terms of currency neither the wage level nor the price level will be altered by bidding up the price of gold. As a matter of fact, during our Civil War, wages and prices in gold rose but little whereas they nearly doubled as measured in currency. This has been ascribed to the fear that currency inflation would continue after the war ended, but that inflation ceased in 1865 and average prices settled to a level that was as much above the level of 1861 as per capita currency was above that level. In 1865 our total stock of money was 6 times our stock of gold coin and bullion, and in 1875 the ratio was 7.5 to 1, as compared with about 2 to 1 in recent years. Wages in currency have followed the per capita currency and not the per capita gold. The bidding up of gold will certainly not affect wages, unless it is accompanied by the printing of paper money that is put into circulation.

Congress meets Jan. 3, and since it will then be apparent to all that the bidding up of gold has failed to raise prices or wages, congress is likely to demand currency inflation. Should currency then be considerably inflated, every contractor who has contracted to build public works at present wages and material prices will be faced with the probability of serious losses.

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Gas Tax Diversion

BASED upon data furnished by the Bureau of Public Roads and the State Highway Departments about $486,000,000 will have been expended during 1933 by State Highway Departments. This sum would have been $206,000,000 larger had it not been for diversions of gasoline taxes and the like.

The worst offender as a diverter of highway funds to other uses was the State of New York. It diverted about $50,000,000, leaving only $13,000,000 for highway work! Texas diverted $17,000,000 and left an equal amount undiverted. Wisconsin diverted $15,000,000 and left only $10,000,000 for roadwork. Illinois diverted nearly $20,000,000 but left about $45,000,000; but in 1934 the diversions will be so great as to leave only $28,000,000.

It is almost unbelievable that only 13 of the 48 states failed to divert large sums of highway funds, and that the total thus diverted is 30 per cent of the amount collected for highway purposes. As a result of these diversions and because of decreases in bond issues and tax collections, the 48 states spent only 60 per cent as much on highway work in 1933 as in 1932. Yet for four years the federal government has been increasing its highway expenditures and urging the states to do likewise, in order to afford employment to the millions of men eager for work.

What is the matter with most state legislators and governors? They gave lip service to the public works programs advocated both by Hoover and Roosevelt, and then "knifed" highway funds to secure money for doles and other purposes. Perhaps most legislators do not know that 75 per cent of our highway mileage is not even surfaced with gravel, and is almost impassible in wet weather. Probably few of them realize that fully half of the surfaced highway mileage has a surfacing that is so narrow as to be dangerous for fast moving traffic. These and other facts should be driven home by highway associations and motor clubs, until every legislator and newspaper editor at least knows that America has barely started to build an adequate highway system.

Judging by newspaper editorials, few editors appreciate the economic need of extensive highway improvement. A campaign to educate newspaper editors may be the most effective way of educating legislators and the public as to the economic mistake made when gasoline taxes are diverted from highway funds.

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The Sand and Gravel Code and the Contractor

The code of the crushed stone, sand, gravel and slag industry has been approved. Its definitions of this industry and its members are evidently intended to include the road contractor who owns a portable plant, and the farmer who owns a gravel pit and loads his own truck with gravel by hand. There would be no objection on the part of such a road contractor or farmer to being classed as a "member" of these aggregate industries, were it not for Article VII, Section 5 of the code. That section provides for a committee of 7 men in each state and gives to them the power to prohibit any member of the industry from installing a new plant or increasing the size of an old plant. The evident object of this section of the code is to restrain competition both by preventing new producers from entering the field and by preventing small producers from becoming big producers.

When the editor was a road contractor he operated a portable stone crushing plant and several portable gravel plants. Had this code been in existence then, he could not have become a road contractor, for the prices charged for crushed stone and gravel plus the cost of haulage to the road would have been so high that his bids would have been too high to secure the contracts. The cost of hauling then was and still is the major part of the cost of stone or gravel delivered on the average road. Hence a road contractor should be free to produce his own stone or gravel at any place near its point of delivery. But if he must secure permission to open new pits, and if that permission must come from a committee whose members wish to force contractors to buy from existing plants, he may be forced either to bid a high price or refrain from bidding.

We question whether any road contractors were consulted when this code was being drafted. It looks like the work of large producers of crushed stone, sand and gravel. At any rate Section 5 seems to have been written by them.

In this connection we call attention to the National Industrial Recovery Act that provides for the expenditure of $400,000,000 of federal money for roads. The rules and regulations for carrying out that act provide that road funds shall be so distributed that road work shall be done in at least 75 per cent of the counties in each state. This means an abnormally wide distribution of roadwork, much of which will be in regions not served economically by any existing gravel or stone plant. This code conflicts with that law, for it acts as a bar to the opening up of new pits and quarries. It may be argued that the state committees in control of this industry may permit a road contractor to open new pits or quarries. But when bids are advertised for roadwork a contractor usually has only two weeks or so in which to visit the job and prepare his bid. Imagine his plight if he is compelled to wait for a "regional committee" and then for a "state committee" and then for the "Administrator" to pass upon his appeal for permission to open those pits!

Section 5 of this code is highly objectionable from the point of view of a road contractor who aims to secure low costs so that he can submit low bids. It is objectionable from other points of view also, but at present we need not discuss them.

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Why Mechanical Successes Are Often Economic Failures

BETWEEN the possibility of doing a thing at all and doing it profitably there often lies a great gulf. Power was first developed by a solar-engine four generations ago, but we seem to be no nearer a profitable solar-engine than then.

Most of the failures of inventors are economic failures, not physical failures. The device was made to work as planned, but, even so, it was less economic than existing ways of rendering the same service. Often, however, the economic failure of a machine is attributable to some defect that could have been remedied, and later was remedied by another inventor. Newcomen's steam-engine worked, but its speed was too slow and its fuel consumption too high. Watt remedied both of these defects at one stroke. The slow speed of the Newcomen engine made the cost per horse-power great, and this caused high interest charges which added to the fuel costs made the horse-power-hour costs prohibitive.

To be profitable a machine must either render a marketable service not previously available, or it must render a previously available service in a more satisfactory manner. The phonograph performed a new service. The bicycle gave a more satisfactory service either as to speed of transport or as to cost, or both.

The great majority of inventions aim at rendering an old form of service at reduced cost. Hence the inventor should usually familiarize himself with the details of the cost of the existing service that he plans to render less costly. This, however, seems rarely to be done. If the object is to lower an existing cost, then that cost must be definitely ascertained, and held constantly in mind.

One of the common mistakes made by inventors of power generating machines arises from failure to divide the annual interest charges and repair expense by the total number of units of annual power output. A slow moving heavy machine usually has a high investment cost and a low output of power units, both of which run up the interest charge per unit of power. This is the case with all machines thus far designed to generate power by means of ocean tides or by means of the current of a river. On the other hand while very rapidly moving parts permit the design of a power machine of light weight and low investment cost per horse-power, there may result such rapid wear of the moving parts that repairs become very expensive, and, what is worse, shutdowns during repairs may be so frequent and so prolonged as greatly to reduce the output. Airplane motors are illustrative of very high costs per horse-power-hour because of their high speed. Were it not that low weight per horse-power is imperative in this case, these high-speed motors would be prohibitively extravagant as generators of power.

Engineers are usually trained to estimate all the elements of cost of generating power, and engineering books discuss these elements in great detail. The man who aims to be an inventor of any prime-mover should familiarize himself with engineering data as to unit-costs of power. Study of patents on prime-movers shows that many of their inventors were so ignorant of costs of power generation that they were doomed to economic failure.

The economic generation of power by means of the sun's heat presents a fascinating problem to the inventor. Ericsson built a great concave mirror that by concentrating the sun's rays, boiled water and ran a steam engine. Perhaps a battery of small lenses would be far less costly than one great mirror. But to bring the cost down sufficiently, it may be necessary not only to invent new ways of manufacturing such lenses, but to manufacture them in quantities hitherto not even contemplated. Possibly the lenses can be most economically made like bottles and filled with a refractive fluid. If the rays from each lens were focused upon a very small glass window in an iron pipe carrying water, the water could be raised far above the boiling point. Clock-like mechanism would move a battery of such lenses as to catch the sun's rays most effectively.

If the solar-engine problem is to be solved the inventor must devote most of his efforts to reducing the cost of the devices by which the solar rays are concentrated. Since Ericsson's time, most inventors have tried to dispense with mirrors and lenses, and have thus been led to make enormous boilers whose cost is, and probably will remain, prohibitive because of their very size per horse-power. Their economic error has been the same as that of inventors of river-current generators of power.

The greatest known generator of power per unit of weight is radium, but it is also the most expensive per unit of power generated. Radium is slowly disintegrating and is giving out heat. If its rate of disintegration could be speeded up so that the entire energy of its radiations could be secured over a period of 30 years, a ton of radium would keep a 15,000 horse-power engine going continuously during 30 years, whereas it would require nearly 1,500,000 tons of coal to do the same thing. But not the faintest hint has been presented by any experiment as to how radium's rate of disintegration can be changed, or as to why it disintegrates at all.

Perhaps the stars, including our sun, shine because some of their internal energy is being squeezed out under the tremendous pressure of gravitation.

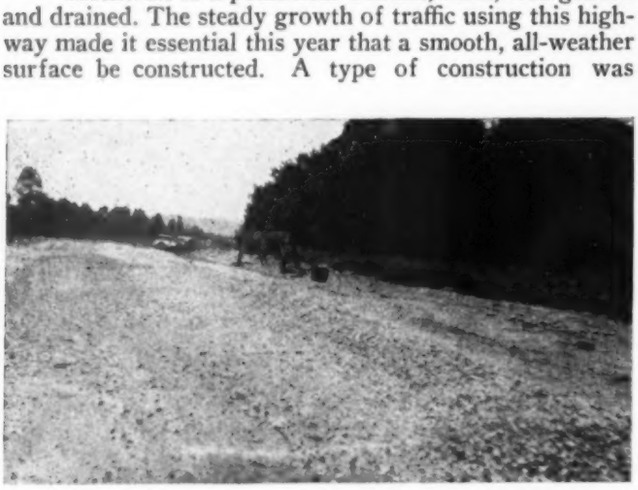
H. P. Gillette

County and Township Roads

A Section Devoted to the Interests of Those Responsible for Secondary Road Improvement

Low-Cost Asphalt Surface for Gravel Base

THREE years ago an 11-mile section of U. S. Highway No. 65 starting at Buffalo River and running northwest to a point near Pindall, Ark., was graded and drained. The steady growth of traffic using this highway made it essential this year that a smooth, all-weather surface be constructed. A type of construction was



Windrow of Crushed Stone in Center of Road Ready to Spread. Road Primed.

sought which, while it would stand up satisfactorily under traffic, would not involve too great an expenditure.

To fufill all the requirements, the Arkansas State Highway Department decided to construct an 8-in. gravel base to be covered by an asphalt mat surface 1 in. thick after rolling.

The existing dirt road was excavated to a depth of 8 ins. and the gravel foundation constructed, which was required by the specification to be not less than 75 per cent metal. A 10-ton roller was employed to consolidate thoroughly the gravel.

After the gravel was properly compacted, it received a prime coat of a medium-curing asphalt cutback, at the

First Application Top; Shoulders Not Finished; Seal Coat to Place.

Seal Coat and Road Mat Finished to White Line

rate of from 3 to 4 tenths gal. per square yard. The base dust had been cleaned out of the limestone, which ranged in size from ¾-in. down to small chips. A grader was employed to spread the windrow of limestone over the road, after which an application of 1 gal. of Texaco rapid-curing asphalt cutback was applied to the square yard. The asphalt and stone were worked repeatedly backward and forward across the road until all of the mineral aggregate was thoroughly coated. Hand labor was employed to bring the road to the proper contour, after which the new surface was thoroughly compacted; was subjected to traffic for a time, after which a windrow

Section of St. Joe to Buffalo River Road

of crusher-run limestone was placed along the center of the road for approximately one mile at a time. The a 7-ton roller was found more satisfactory for the purpose than either the 5- or 10-ton size.

The highway was thrown open to traffic for two weeks, at the end of which a seal coat of the same asphaltic material was applied to the road at the rate of 3/10 gal. to the square yard.

The highway was constructed by the Roy Tanner Paving Co. The work was done under the direct supervision of the Arkansas Highway Department, of which W. W. Zass is chief engineer. J. M. Page, Federal Government Engineer also assisted in supervision of the work.

Grout Flow in Cement Bound Macadam

IN THE construction of cement bound macadam pavement penetration of grout to the subgrade is essential. Ease and certainty of penetration, of course, depend upon the fluidity of the grout. Knowledge and control of the factors affecting fluidity, therefore, are important. Fundamental factors influencing fluidity are: size and gradation of fine aggregate; amount of mixing water; and proportion of cement to fine aggregate. An interesting discussion of the first two factors, based on data obtained during the construction of the test road near Elmhurst, Ill., described in our September issue, is given in the October-November issue of Concrete Highways and Public Improvements Magazine.

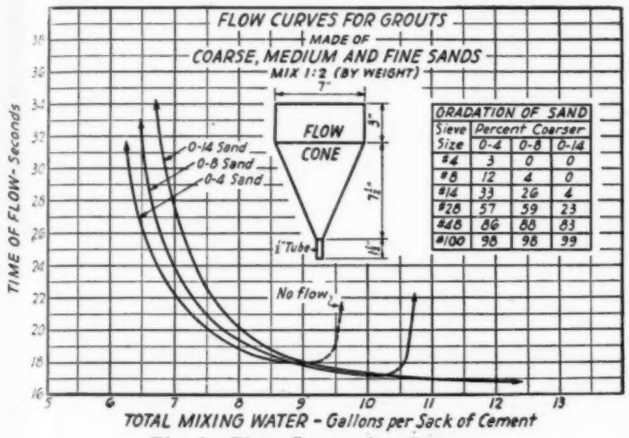


Fig. 1—Flow Curves for Grouts.

"Flow Cone" Developed—To study these factors it was first necessary to develop apparatus to measure the fluidity of grouts, then correlate the results of such tests to actual construction conditions in the field. A "flow cone" was devised which satisfactorily and consistently measures the fluidity under variable conditions, as well as approximate flow under actual working conditions.

This flow cone consists essentially of a funnel having a capacity of 221 cu. ins., to the bottom of which is fitted a ½- x 1½-in. tube. It is shown in Fig. 1.

In making a test, the cone, rigidly supported in place, is filled with grout which is allowed to settle five seconds for uniformity before the flow is started. The net time, in seconds, required for the cone to empty is taken as the index of fluidity of the grout. Typical flow curves made with the apparatus are shown in Fig. 1.

Characteristics of Grouts—A study of these curves shows that within certain limits the fluidity of the grout, as measured by a decreasing flow time, increases with the amount of mixing water. It may also be seen that, for the same fluidity or flow time, more mixing water per sack of cement is required for grouts made of fine sand than coarser sands. For example, a 1:2 mix grout, (see Fig. 1) requires 7¼, 7.5 and 7¾ gals. of water per sack of cement to give a flow of 21 seconds for sands graded 0-4, 0-8, and 0-14, respectively.

Further study of the curves shows that fluidity is increased but little by additional mixing water above that required to produce a flow of about 19 seconds; also, that for the coarser sands additional mixing water actually stops or decreases the rate of flow. This is no doubt caused by segregation resulting from the inability of thinner pastes to hold the larger sand particles in suspension, as a similar effect is not evident for the 0-14 sand within limits of the test.

Tests and observations in the field during construction enable the fixing of rather definite limits of usable fluidities or rates of flow which will readily penetrate the space between coarse aggregate particles. It was found necessary to use grouts having a flow time of not more than 20 to 22 seconds to penetrate 1- to 2-in. aggregate; not more than 18 to 19 seconds flow time to penetrate ¾- to 1½-in. aggregate.

Effect of Excess Water—Less liquid grouts do not flow with certainty into the coarse aggregate and more liquid grouts are not required and bring certain definite disadvantages. The surface is more difficult to finish. Free water from excessively liquid grouts tends to flow ahead of grouting operations, unnecessarily softening the sub-grade. Most important of all, excessive water may cause segregation in the grout, resulting in the clogging of the spaces between the coarse aggregate and preventing uniform penetration.

The point at which segregation occurs in grout proportioned 1-2 by weight and made with coarse (0-4), medium (0-8) and fine (0-14) sands is shown graphically in Fig. 2. The same chart shows the amounts of mixing water required to produce grouts of usable rates of flow. The difference in the amounts of mixing water required to produce a usable flow and that producing segregation may be termed the "safety factor" for that particular combination. It is believed that the safety factor should not be less than ½ gallon per sack of cement. It is apparent from a study of Fig. 2 that for any given fluidity the safety factor is greater for grout made with finer sands, or that a more fluid group may be safely attained by the use of the finer sands.

It may also be seen from further study of Fig. 2 that grout proportioned 1:2 by weight and made of 0-4 sand is just barely safe to use with an amount of mixing water required to produce a flow rate of 21 seconds. This flow rate, as previously mentioned, will readily penetrate 1-in. and 2-in. coarse aggregate. But, since it falls so close to the margin of safety, it should be considered as usable only for larger than, or the most favorable cases of, 1-in. to 2-in. coarse aggregate.

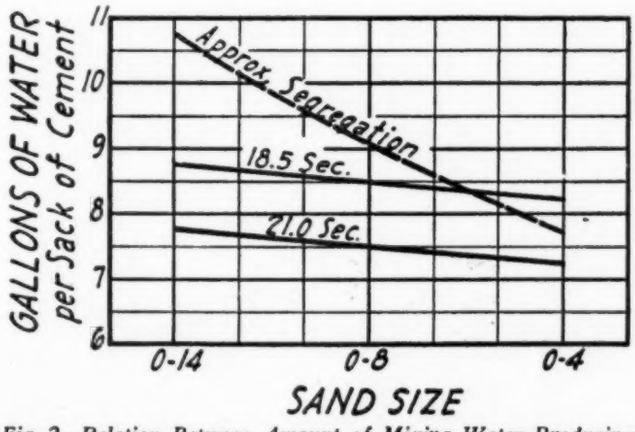


Fig. 2—Relation Between Amount of Mixing Water Producing Flows of 18.5 and 21 Seconds and That Causing Segregation of Grouts Made from Coarse, Medium and Fine Sands—Mix 1:2 (by weight).

Similar grouts made of the 0-8 sand are amply safe for a fluidity corresponding to an average flow of 21 seconds, but are just barely within safe limits for a fluidity corresponding to an average flow time of 18.5 seconds. The use of grout made from the 0-8 sand is

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Know About Asphalt?

AT ONE time you knew this type of material as road oil, formerly used to lay dust. The old road oil has been developed into a carefully manufactured Liquid Asphalt. The old dust-laying practice has developed new and improved methods of low-cost road building.

Standard Liquid Asphalt is a road building bonding material produced to meet rigid specifications and contains only petroleum products which the Standard Oil Company (Indiana), a pioneer in manufacturing road building materials, has found by long experience to give best results.

Standard Liquid Asphalt is made in four grades, each grade having a different viscosity, making available a material suitable to any particular road construction problem. Regardless of the type of aggregate you use, condition of the road, season of the year or method of mixing, one of the four grades of Standard Liquid Asphalt will meet your requirements.

The first barrel of Standard Asphalt Road Oil was sold in 1907. Standard Liquid Asphalt is now being used on 8,000 miles of road each year.

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(Indiana)

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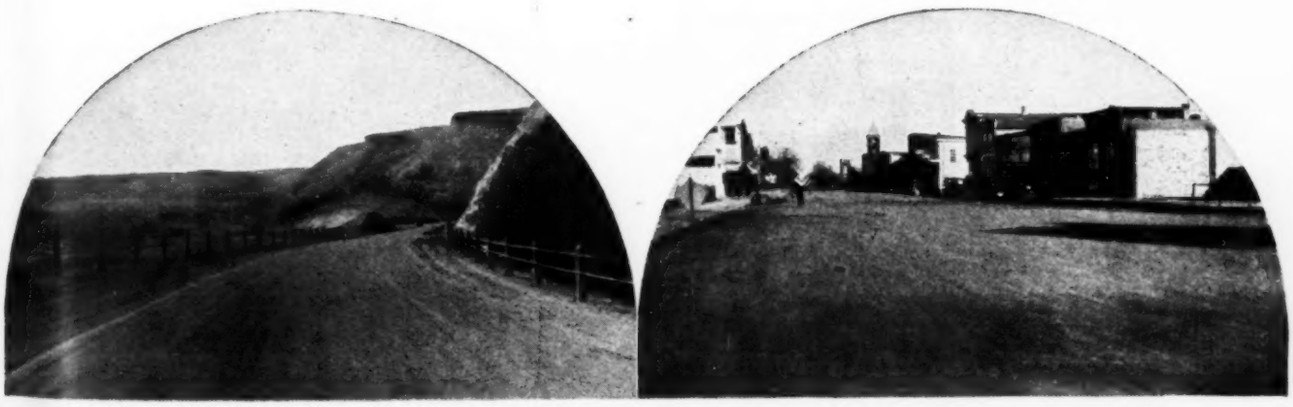


ASPHALTS FOR EVERY PURPOSE

considered amply safe for usual conditions of 1-in. to 2-in. coarse aggregate and usable for the more favorable conditions of ¾- to 1½-in. coarse aggregate. It is considered desirable to use grouts made of an 0-14 sand where the size or condition of the coarse aggregate requires use of more liquid grouts than that corresponding to a flow time of 18.5 seconds.

Conclusions—In summary, the fluidity of grout required to penetrate coarse aggregate readily depends on the size and shape of the spaces between the coarse aggregate particles. The fluidity of rate of flow, in a grout of a given mix, can be safely increased by adding more mixing water up to the point of segregation which, however, is dependent on the size and gradation of the fine aggregate. These relationships and their application for satisfactory penetration were developed by observations during construction of the experimental road and by tests made with the flow cone.

Characteristic flow curves of grouts to be used, in conjunction with a knowledge of the flow required to penetrate the coarse aggregate readily, are invaluable in the construction of cement bound macadam. During construction frequent use of the cone makes good field control possible and insures grout of uniform characteristics. Chance may in this way be largely eliminated as a factor in penetration of coarse aggregate.

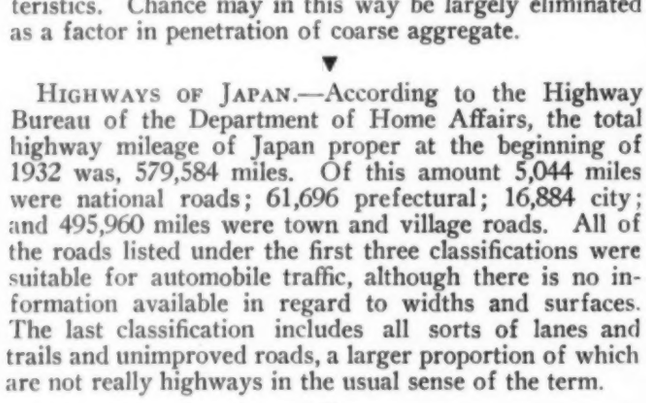
▼

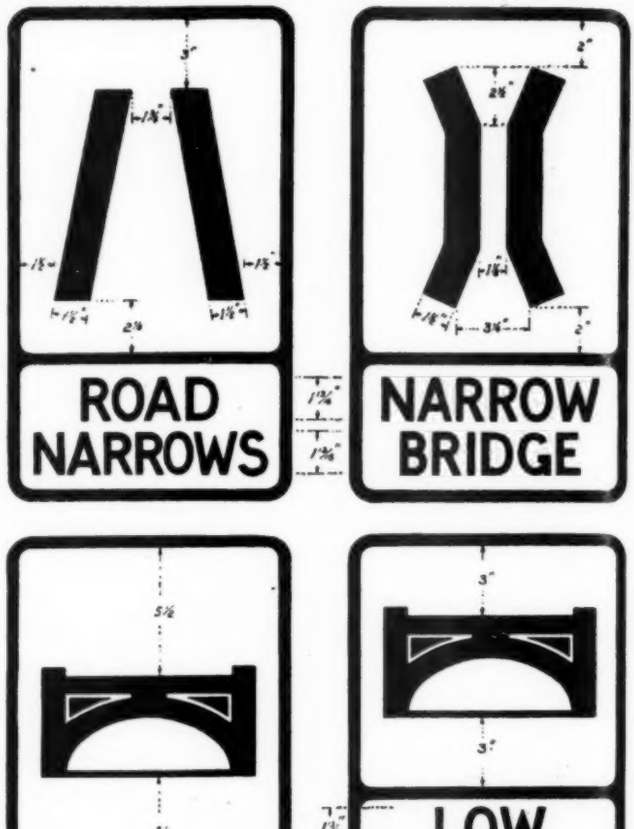
HIGHWAYS OF JAPAN.—According to the Highway Bureau of the Department of Home Affairs, the total highway mileage of Japan proper at the beginning of 1932 was, 579,584 miles. Of this amount 5,044 miles were national roads; 61,696 prefectural; 16,884 city; and 495,960 miles were town and village roads. All of the roads listed under the first three classifications were suitable for automobile traffic, although there is no information available in regard to widths and surfaces. The last classification includes all sorts of lanes and trails and unimproved roads, a larger proportion of which are not really highways in the usual sense of the term.

▼

Some British Traffic Signs

The Ministry of Transport of Great Britain in December, 1931, appointed a committee to consider the existing system of traffic signs in that country and to make recommendtions. The committee, of which Sir Henry Maybury was chairman, has recently issued its report. The committee recommended that certain standard warning signs be retained. They also recommended the use of some new standard warning signs for calling attention to the need for caution in approaching narrow roads, narrow and low bridges and hospitals. Some of these signs are illustrated herewith.





British Warning Signs

Peter J. Hurtgen Dies

P. J. Hurtgen, Director of Public Works of Kenosha, Wis., for the past 14 years, died Nov. 15 in Kenosha. He was on his way to work in the morning when he was seized with a heart attack and his car crashed into a tree.

Mr. Hurtgen was born March 20, 1874 at Pewaukee, Wis. He was a graduate of the Milwaukee School of Engineering and for several years after graduation he was attached to the engineering department of the City of Milwaukee and then had charge of construction work for T. M. E. R. & L. Co. He then became city engineer of Burlington, Wis., at the same time acting as consulting engineer for the towns of Delavan, Elkhorn, South Milwaukee, Lake Geneva and Marshfield.

In 1916 he became city engineer of Kenosha, Wis.; in 1919 he was made director of public works and had held that position since. As director of public works of the City of Kenosha he instigated many progressive improvements in the city's drainage, water and sanitary system.

Since 1928 Mr. Hurtgen has been treasurer of the International Association of Public Works Officials and was active in civic affairs, being secretary of the Kenosha Safety Council. He also was active in many fraternal orders.

Construction and Maintenance of Roads In Harris County, Texas

By J. A. WALLING
Commissioner, Harris County, Texas

IN this paper I intend to briefly outline and discuss the problems of county road construction and maintenance as applied to Harris County. No doubt a majority of the problems we have are common to all counties, others perhaps apply principally to the counties along the Gulf Coast or metropolitan counties.

Our principal road problems in the southern part of the county is drainage. In the northern part of the county although the land is more rolling, it is cut up considerably by water courses and requires innumerable bridges and culverts.

Back to the Farm Movement—A few years ago the population of Harris County was principally in Houston or in small municipalities along the Ship Channel. The depression years have caused an ever increasing movement away from the congested cities to the country. People have moved to the rural districts where they could cultivate an acre or two of ground, keep a cow, chickens, etc., even though continuing to work in commercial or industrial institutions. In this way they are able to supplement their greatly decreased incomes with home grown food products. Many acreage subdivisions have been developed and sold out. This trend of the population from the city to the country has increased road demands while available funds for road and bridge construction have actually decreased. This is the most difficult of all problems to overcome; that of meeting heavier demands with less money. It is a problem that is universal in every state and county in this country.

Another trend in our rural development that increases the demand on our road and bridge funds is that of the consolidated school districts with the consequent establishment of school bus routes. The old 1 or 2-room school shacks are being supplanted by Central schools with modern equipment and standards of education equal to that of the cities. Education for our children must be maintained at the highest possible standard. School bus routes must be made all weather roads and maintained as such. Additional R. F. D. mail routes, as rural population increases, adds to the burden of an over-burdened road and bridge fund.

The need of new sources of funds for lateral road construction and maintenance is well recognized and has been the subject matter of so many articles in magazines and papers, that we will merely state here that the financing of lateral road construction and maintenance is the most difficult problem we are up against in the metropolitan counties as well as in the rural counties.

No tax payer objects to paying for services when he feels that he is getting the best that available money could buy. A thorough survey of the county as to road needs, sources of road building material in the county, traffic over the roads should be made and a road plan developed.

Comprehensive Plan of Construction Started in 1927—In 1926 Harris County literally was in the mud. A few of the major highways, or roads, leading out of Houston had a shell, gravel or in a few cases an asphalt surface of light type construction. The maintenance of these main roads took all available money and yet they suffered from lack of maintenance. That year a comprehensive plan was made and a bond issue voted giving adequate funds for the construction of these main highways of a suitable type to carry the traffic with a minimum of maintenance cost. This construction work began in 1927. Immediately these main roads were taken care of by bond money, road and bridge funds were released for the improvement and surfacing of the more important lateral roads.

In the Harris County Plan an 80 ft. minimum width of right of way was adopted for all arterial highways and a minimum of 60 ft. for any road. This means that on many roads that we rebuild, or improve, it is necessary to obtain additional right of way. It is impossible to build a road on less than 60 ft., especially where drainage is such an important item. Many of our old roads have only a 30 or 40 ft. right of way. It would seem that people living on a road would willingly give a few feet of additional right of way in order to permit improvement of their roads, yet in almost every instance you will find a few obstructionists who only think of it as an easy way to get a few dollars. Thankfully, these obstructionists are relatively few in number, yet they do cause considerable expense and sometimes delay in getting the improvement work started. Every dollar spent for right of way means a dollar less for road improvement. When one considers the benefits the owner receives by having his road improved and the fact that his neighbors who perhaps never use the road pay as much for the improvement as he does, it is hard to conceive through what channel his mind works in when he expects the county to practically pay him for the permission to give him road improvement.

Securing Right of Way—Harris County early in the program adopted a policy of not paying for land for right of way except by condemnation unless the land was so damaged by the new or widened right of way as to more than offset benefits and then the payment would be for damages and not for land. This was done in justice to those who willingly gave needed right of way. By having a plan and a fixed policy as to right of way widths, future right of way troubles will be eliminated. Every time a new road is opened up it is just as easy to get 60 ft. of right of way as 40 ft. Every time a new subdivision is put on make the subdivider lay out not less than 60 ft. wide. You will find him willing and the commissioners court should not approve any subdivision with roads less than 60 ft. wide.

Another obstacle to improvement of roads is the need for relocation and correction of alignment. A plan will assure that new roads are properly located and have good alignment for fast moving traffic. There are many roads that except for short stretches that become bad in wet weather, could be classified as all weather roads. These bad stretches should and do receive first attention. It would be economy if when the bad stretches are improved we make the improvement fit in with the ultimate location and construction of the road. To do this requires a plan. To properly check up the layout of new

subdivision requires a definite plan. A plan, therefore, is a requisite to the proper construction or maintenance of any system of roads.

There is no blame to be attached to those who laid out the old narrow crooked roads, for no one in those days, had the slightest conception of the change in transportation facilities that has taken place in the last generation. We should, however, knowing what we do, see that future generations do not have to pay so dearly to correct our faults. It should be made possible for them to improve our work without having to discard and tear out what we have constructed.

Harris County started on a comprehensive plan of road construction in 1927. A large part of the bonded issue was allocated to state highways. Most of the state highways in Harris County were built largely with county funds as the county put up two dollars to the state's one. It can be said that very nearly every mile of surfaced highway or road has been constructed since 1927 as practically all of the surfaced roads then, have been improved with a higher type of surface since.

Types of Highway—There are 158.56 miles of state highways in Harris County, of which 132.57 miles are concrete or equal, 18.19 miles asphalt surface treated, gravel or macadam and 7.8 miles dirt. The state highway system, therefore, is less than 8 per cent of the entire official road system of Harris County. Figures for all states of the Union show that the average percentage of state roads to entire mileage is in excess of 10 per cent. It may be seen therefore that Harris County is below the average in state highway mileage by approximately 2 per cent.

There are 1857.49 miles of county roads in Harris County of which 83.03 miles are concrete or equal, 215.35 miles Asphalt surface treated shell, gravel or macadam; 583.98 miles of shell or gravel; and 975.13 miles of dirt. In addition to the state highways and county roads are roads dedicated to the public by land developers but settlement along them has not justified the county taking them over for maintenance.

There are so many subdivisions being put on the market by land developers that it would be impossible for Harris County to take the roads over until actual settlement on them justify it. The land developer builds his own roads and maintains them as long as the development is active.

All our county roads are logged and given a number. They are sectionized as to type and all charges out of the road and bridge fund must be charged against some road, that is on the log. No work is permitted on any road that has not been accepted by the court as a county road. It is sometimes difficult to make some people see the difference between a public road and a county road.

Our road and bridge funds are budgeted. Maintenance being the first care of the Commissioners Court, the maintenance budget is first prepared. As our auditing system gives us a breakdown on maintenance cost, we are able to definitely say what each type of surface cost the past year to maintain. We have an accurate record of miles of different types of roads in the county. From this information the maintenance budget is made up predicated on past costs.

Cost of Highway Maintenance—Maintenance costs are roughly as follows:

Earth, $125.00 per mile; Sand, $150.00 per mile; Shell, $479.00 per mile; Gravel, $288.00 per mile; Shell, Surface Treated, $338.00 per mile; Gravel, Surface Treated, $354.00 per mile; Rock Asphalt on Shell base, $291.00 per mile; Macadam, Shell base, $184.00 per mile; Macadam, Gravel base, Surface Treated, $105.00 per mile; Cement Concrete, $205.00 per mile; Bituminous Concrete, $31.00 per mile. An average of all types of $231.00 per mile.

The construction budget, which has been practically nil the past two years, is made up specifically as to roads that are to be improved and from engineer's estimates of the work to be done. Construction costs of light type surfaces in Harris County is at least double the cost in many counties of Texas. There are no road building materials to be found in Harris County other than shell. The freight alone paid on road gravel is twice the cost of the gravel at the pit. Shell is expensive to produce. Due to high water table our grading of roads costs more. Numerous outfall ditches are necessary as a part of the grading work to drain our roads. Numerous culverts and bridges are needed. In fact a surface treated gravel road that would cost about $10,000.00 per mile in a West Texas county, costs about $25,000.00 in Harris County. It has been found that very often it is cheaper to build a concrete road than one of a lighter type.

The total value of roads and bridges in Harris County approaches $20,000,000.00 with an additional $1,250,000.00 spent on roads built by Harris County but now lying within the city limits of Houston.

In closing I wish to stress the most difficult problems we have to solve, which are:

1. Financing of lateral roads which is a problem being studied by some of the best minds of the country.
2. Getting proper locations not only for the present but which fit into the ultimate plan.
3. Development of better low priced surfaces. This requires some experimentation as to use of materials available locally.
4. Widening and correcting alignments of old existing roads.

Acknowledgement—The foregoing is an abstract of a paper presented Oct. 27 at the annual meeting of the County Judges and Commissioners Association of Texas.

Many Public Works Highway Projects Under Construction

Completion of 59 public works highway projects up to November 25, at a cost of $1,301,000, was announced Nov. 29 by the Bureau of Public Roads, U. S. Department of Agriculture. This work was completed under the Public Works Administration highway fund allotment provided for in the National Industrial Recovery Act.

Awards on 3,266 projects at a cost amounting to $165,309,000 have been made, out of a total of 4,239 projects advertised for contract amounting to an estimated expenditure of $213,551,000. On Nov. 25, the work advertised for contract or started by day labor employed by the highway authorities represented 50.1 per cent of the $400,000,000 provided for highways by the Public Works Administration under Section 204 of the National Industrial Recovery Act.

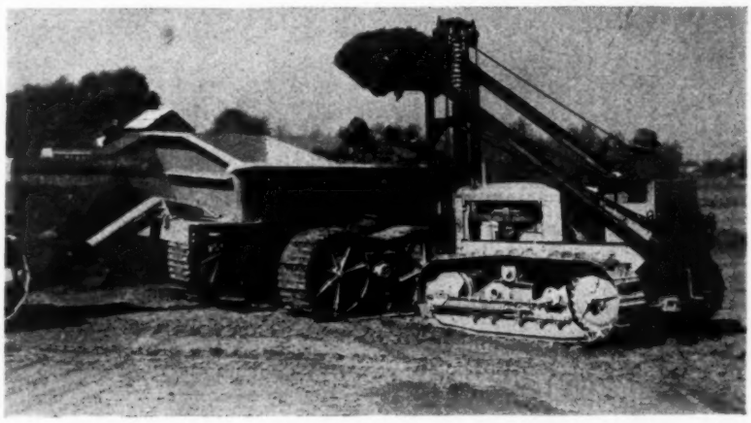
Highway work under construction by the states under Section 204 was employing directly on highway work a total of 134,805 men on November 25, the Bureau of Public Roads reports. This force of men was divided between contract and day labor work as follows: 1,005,512 men on 1,890 contract projects and 34,293 men on 533 projects on which the labor is directly employed by the highway authorities.

The estimated total cost of the work under construction on November 25 was $129,060,000, of which $116,525,000 was by contract and $12,535,000 was by day labor employed directly by the highway authorities.

New Equipment and Materials

A New Loader

In collaboration with Allis-Chalmers, the Frank G. Hough Co. of Chicago, Ill., has developed a new front end shovel loader for the A-C Model "M" tractor. This handy tool is not new to the construction industry, but the new features found in this new development of Allis-Chalmers and the Hough Company are stated to be quite different than found on other similar equipment. The A-C Model "M" tractor is equipped with a special wide gauge long track, and the truck frames are rigidly mounted to eliminate all oscillation. By thus eliminating the oscillation it is possible to mount the loader more solidly. All thrusts are taken on heavy channels supported on the long truck frame. There are five truck rollers per track on this special model which materially spreads the weight of the loader.



New Front End Shovel Loader. Allis-Chalmers Dump Wagon with the New Four Truck Roller Wagon Track Also Is Shown.

There are many uses for the loader, both in the field and around factories. The standard ⅓-yd bucket can be removed and a bulldozer blade installed, or a larger bucket can be used for handling snow and other light material. The unit is hydraulically controlled and is completely equipped with counter weights and rear starting crank. The drawbar is clear for use on any pulling work. Complete information and specifications may be obtained from either the Allis-Chalmers Manufacturing Co., Tractor Division, Milwaukee, Wis., or the Frank G. Hough Co., 919 North Michigan Ave., Chicago, Ill.

New Diesel Locomotive

The Whitcomb Locomotive Co., Rochelle, Ill., subsidiary of the Baldwin Locomotive Works, has recently shipped to Puerto Rico a 12-ton 0-4-0 Diesel locomotive with mechanical drive. It is stated the locomotive will start 390 trailing tons on the level with sanded rail, or 290 tons with clean dry rail. It will haul 324 trailing tons up to 10.82 miles per hour and 190 tons up to 16.87 miles per hour, thus affording a wide range of effectiveness for industrial haulage. It can be built to any track gauge from 30 in. up.

Power is furnished by a 6-cylinder, 4⅞ in. x 6 in. full Diesel engine, rated conservatively by the locomotive builder at 85 net horsepower at 1200 r.p.m.

The locomotive frame is a unit casting with integral engine and transmission mountings, thus insuring accurate and permanent alignment. Semi-elliptical springs are used, with full cross equalization, which enables the locomotive to negotiate rough tracks without derailment.

The clutch, designed and manufactured by the locomotive builder especially for locomotive service, is of the multiple disc, cork insert type running in oil. Eight pairs of 15¼ in. diameter discs are used.

Transmission is by selective gears, with four speeds forward and four speeds reverse. Drive is from a jack shaft directly to the rear axle by two chains and from rear axle to front axle by one chain. Only two gear reductions are employed, thus delivering a high percentage of the engine power to the driving wheels.

New Whitcomb 12-Ton Diesel Locomotive

Special attention has been given to providing a clean cut design with a maximum of accessibility and convenience for the operating and maintenance personnel as evidenced by the accompanying illustration.

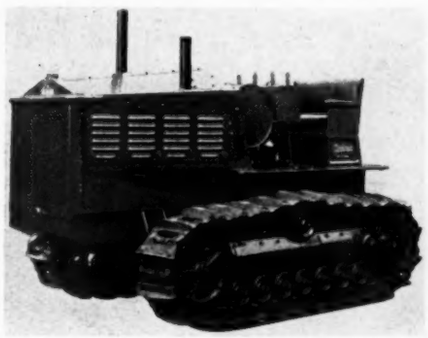
The Whitcomb series of Diesel powered locomotives ranges from 8 tons to 30 tons with mechanical drive, and from 30 tons to 60 tons with electric drive. In the larger sizes, designed for railroad and heavy industrial service, two engines are used per locomotive, each engine driving a generator. Swivel trucks each carry two motors, directly geared to the axles.

New 80 Diesel Tractor

A Diesel crawler tractor in the 80 H. P. class, which develops 85 H. P. in second gear, has been announced by the Cleveland Tractor Co., Cleveland, O. Other than engine, the Clectrac Diesel has the same specifications as the gasoline powered Cletrac 80.

Wherever possible, the features of the Cletrac 80 gasoline engine have been incorporated in the Diesel engine. For example, the underhung crankshaft and the "through" bolts which pass through the cylinder heads, block, crankcase and main bearing caps so that all vertical stresses are transferred from the cylinder heads directly to the crankcase, have been included as features in the Cletrac Diesel engine.

A Bosch fuel distributing pump and fuel pump are used. The fuel delivery tubes lead from the pump to the nozzles on the left side of the engine.



New Cletrac 80 Diesel Tractor

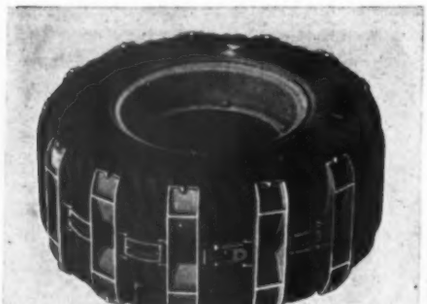
Starting the Cletrac 80 Diesel is stated to be as easy as starting the Cletrac 80 gasoline tractor, as electrical equipment of ample capacity is standard on the Cletrac Diesel. Another advantage of electrical equipment of this type is that it permits the installation of lights at a minimum expense.

The Cleveland Tractor Co. is offering Diesel power in both its standard "80" and in the Blue Ox Logger.

Traction Treads for Dual Pneumatic Tires

Treads for giving added traction to dual pneumatic tired trucks and tractors in mud, sand, snow and ice have been brought out by the W. A. Riddell Co., Bucyrus, Ohio. The materials used in construction of these Warco J. & S. traction treads are of the best obtainable. Wearing shoes, links, and pins are 40-50 high carbon, heat treated steel castings to insure maximum wear. Pins are large, and easily removed

by the simple method of removing but one keeper pin. The treads are quickly and easily adjustable, having a self-locking toggle clamp with turnbuckle adjustment for compensating tire wear or to provide for variation in tire sizes. The inside of the tread plates is a smooth surface slightly curved to fit the contour of the tire. The



Warco J. & S. Traction Treads

tread plates do not mar or injure the tire in any way. In fact during a year's actual test on a machine doing heavy construction work it was found they were preserving the life of the tire. The treads are held against the tire with sufficient tension to prevent their chaffing or slipping.

The treads are so designed that quick detachable lugs or grouters can be quickly and easily attached for use when needed in extreme conditions.

New Loader

A new front end loader has been brought out by the Euclid-Armington Road Machinery Co., Cleveland, O. This is a compact, balanced unit that can be easily and

Euclid Front End Loader

quackly attached to the standard or Hillside 20, 25 or 35 without drilling or altering the tractor. The design of Cletrac tractor utilizes the operating mechanism on the rear of the tractor as a counterbalance.

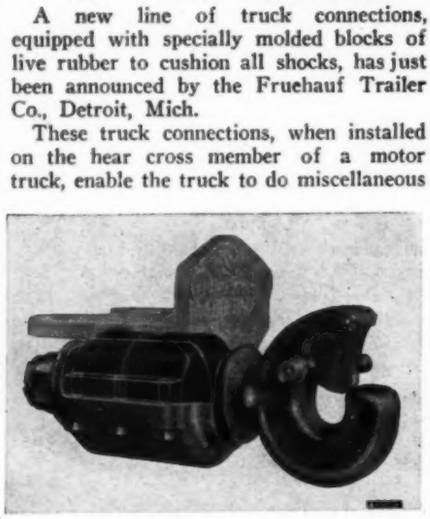
The unit is hydraulically operated and is controlled by a single lever. The bucket automatically stops at its highest and lowest position and may be dumped at any desired height. The tractor may be used for other work with the loader attached, or by the removal of two bolts on the lifter arms and the collars on the cross shaft the tractor can be quickly backed out of the bucket and push arms.

The loader does not use a vertical boom. This gives it a low overall height. The size and shape of the bucket can be changed to suit conditions or types of material being handled.

New Truck Connection

A new line of truck connections, equipped with specially molded blocks of live rubber to cushion all shocks, has just been announced by the Fruehauf Trailer Co., Detroit, Mich.

These truck connections, when installed on the hear cross member of a motor truck, enable the truck to do miscellaneous



Hook Type Truck Connection

towing jobs of all kinds or to pull a 4-wheel trailer. Two types of connections are available: the hook type (illustrated) and the conventional clevis type.

The molded rubber section, which replaces the draft spring formerly used, is completely encased against weather and dirt, and is designed to absorb the shock of either vertical or horizontal strains.

Automatic Tripping Blade Snow Plow

The 1934 models of the automatic tripping blade snow plows of the Anderson Engineering Co., Statler Bldg., Boston, Mass., have been built with more modern and superior engineering practice. This shows up in such features as the use of a great deal of alloy steel, such as is found in the most vital parts of modern motor cars.

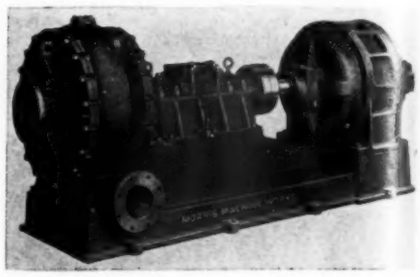
The plows are made in all-rivetted or welded types and in all lengths and heights of mould boards. The heavy duty plow for 2-ton and larger trucks with either enclosed gear or hydraulic lift weighs approximately 1350 lbs. and has roller bearings throughout. The light duty plow for 1 to 2 ton trucks (both enclosed gear and hydraulic lift types) weighs approximatley 825 lbs.

Among the many advantages of the hydraulic lift, possibly the most important is the ease of installation on trucks with the latest type of cabs. The tubing may be located as shown above, but the most approved method is to bring it up through the floor boards. The pump can be fastened in an out of the way place, such as next to the gear shift lever, or can be left loose on the floor or bolted to the dash. These hydraulic units are quickly installed to replace any older type lifts.

Attachment of the plows is by the simplest method possible. Fittings are available for all makes of trucks. Once attached, the axle clamps and lifting mechanism remain on the truck, so that attaching or detaching is a job of only a very few minutes. In operation, the effort required for raising the plow is surprisingly easy.

New Heavy-Duty Dredging Pump for High Heads

In accordance with its policy of furnishing exactly suitable types of pumping equipment for each individual class of service, Morris Machine Works has added to its line of centrifugal pumps a design which has been specially developed for handling extremely abrasive mixtures against high heads.



New Morris Heavy Duty Dredging Pump

In this new design, known as the Type F heavy duty dredging pump, all parts subject to wear, such as the casing, impeller, disc, liners, sealing and throat rings, are made of semi-steel, manganese steel, or special Morris alloys depending on the severity of the service. The casing and impeller are of large diameter so that the pump will run at comparatively low speed even when operating against high head.

The specially selected wear-resistant metals and low speed operation of these pumps are both important factors in reducing wear and resulting maintenance

Anderson Automatic Tripping Blade Snow Plow

expense. In addition, the design includes several special features that help to maintain the original high efficiency of the pump and to minimize operating and upkeep costs. For example, the position of the impeller can be adjusted from the outside of the pump to take up wear on the suction sealing ring and prevent internal leakage. All parts are heavily proportioned for strength and rigidity, and the parts subject to greatest wear are designed to permit quick and economical replacement when necessary after long service.

The pumps are built in a complete range of sizes from 4 in. to 15 in. discharge, for total heads up to 150 ft., and for operation by electric motor or belt. Complete information can be obtained by addressing Morris Machine Works, Baldwinsville, New York.

Homestead Presents Model "D" Hypressure Jenny

The Homestead Valve Manufacturing Co., Coraopolis, Pa., has brought out a new, fully-automatic model of the Hypressure Jenny, their highpowered machine for all-purpose cleaning, paint-stripping or sterilizing. The improved and simplified unit is termed the Model "D."

The 1934 Model Jenny follows the earlier models in its essential characteristic—

Model "D" Hypressure Jenny, Portable Type

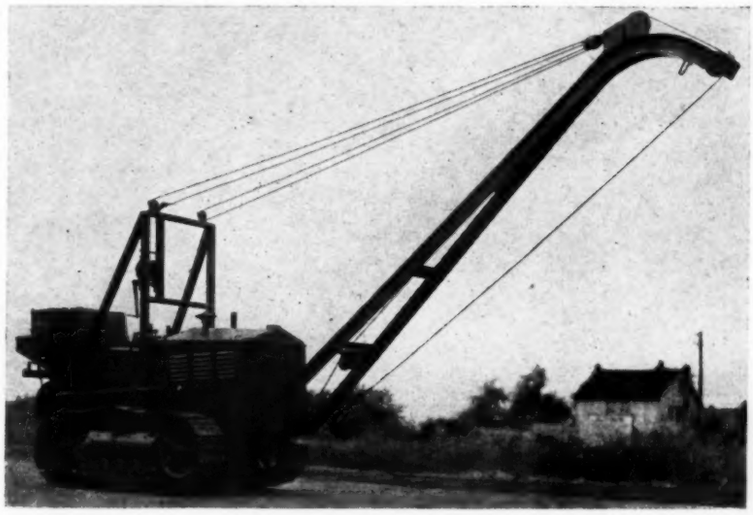
the generation of a vapor blast, combining in any desired proportion the basic requisites for thorough cleaning: heat, pressure and the proper cleaning solvent or solvents for the work to be done. In the engineering and operating details of the unit, however, diligent research and valuable field experience have brought sweeping refinements.

The new model is electric-motor driven, operating and lighting current, and is arranged for instant starting from a push-button switch. The fuel-oil burner used for heat generation is of the reliable pressure atomizinz type, as used for household heating purposes. Ignition is by an automatic electric spark. Throughout, the Model "D" Jenny is engineered for one-man operation, and is entirely automatic and self-contained; all necessary safety devices for this type of operation being part of the design.

The Model "D" Hypressure Jenny has been made fully enclosed and compact, for maximum ease of handling. The portable type, shown here, is only 30 in. wide, 55 in. long, and 70 in. high, enabling it to pass through any ordinary doorway, or enter any ordinary elevator. The machine is also available in stationary types, for truck or floor mounting.

Commercial Utility Crane on Cletrac

The Utility crane of The Commercial Iron Works, Portland, Ore., is now available for mounting on the Model 20 and 25 tractors of The Cleveland Tractor Co., Cleveland, O. This equipment is a sturdy, compact, combined crane and winch unit that is adaptable to a wide range of work. The boom is of the goose-neck type which makes it possible for the crane to pick up airplane motors, or rather material when it is necessary to reach forward over loads that would interfere with the boom of the more common types of cranes.

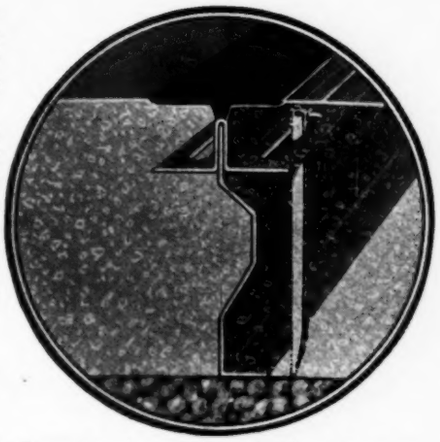


Commercial Utility Crane

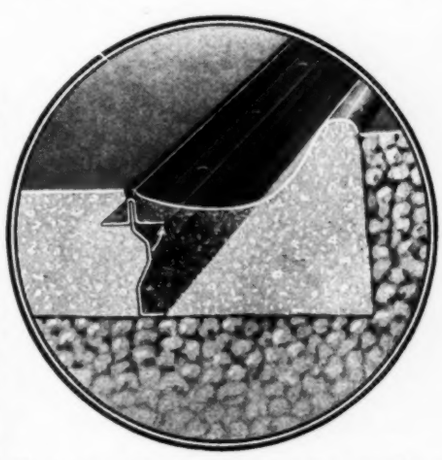
New Ace Joints

Several additions have been made to the line of Ace Joints of the American Concrete Expansion Joint Co., 3215 La Salle-Wacker Bldg., Chicago, Ill. One of these is a longitudinal construction joint especially designed for the formation of the longitudinal joint. It is stated that on account of its shape and design, it is possible to secure tremendous lateral stiffness with the materials used. The wing caps on this joint are staggered at the ends in such a manner as to provide adequate end-joining of the joint sections. Slots are provided for driving pins into the subgrade to hold the joint in place during construction, and these pins have three contact points with the joint, one on one side and two on the other. The method of joining the sections enables this longitudinal joint to conform to any degree of vertical curvature.

Twenty-six gauge sheet steel is used throughout for the construction of the standard joint, but when specified, the wing top sections of the joint will be fur-



Cross Section of Longitudinal Construction Joint and the Transverse Construction Joint, Minus Thickened Edge Shoe of the Latter.



Close-up of the Longitudinal Construction Joint Being Used as a Curb Joint.

nished in 12-ounce copper at an extra charge.

The longitudinal joint is punched at proper intervals for the insertion of ½-in. deformed dowels across the joint. These dowels are imbedded in the concrete of adjacent sections so as to hold the sections together, thus taking advantage of the interlocking or load transmitting characteristic of this joint.

Another joint is a transverse construction joint of a design similar to that just described, except that this joint is equipped with slip dowels, triangular shoes for obtaining thickened edges, and sliding end clips for anchoring the joint into place during construction by sliding the clips under the side forms. This standard joint is made of sheet steel, but when specified, a copper wing top may also be furnished at an extra charge.

This joint provides a means of controlling transverse cracking by dividing the slab into sections of suitable length. Since these joints are equipped with dowel bars and sockets for load transmission along with shear bars, it is stated no weakness results from their introduction into the pavement slab. The Ace joints have been approved by the State Highway Department of Illinois for use on state and county construction.

Recent United States Patents Relating to Roads

Compiled by Patent & Technical Information Service, 1336 New York Avenue, N. W., Washington, D. C.

OCTOBER 3, 1933

1,928,852. **Road Machine.** Daniel E. Dillow, Gruver, Tex. In a road scraping machine, a frame including spaced bars, transversely disposed bars secured to the first mentioned bars, arms having a plurality of openings formed therein, scraping blades connected with the arms, bolts extending through the first mentioned bars of the frame and the arms, adjustably connecting the arms to the frame, and means for operating the arms simultaneously to adjust the scraping blades.

1,929,215. **Process of Treating Sunken Pavements.** John W. Poulter, Milwaukee, Wis. The process of raising pavement slabs which comprises the steps of forcing a mobile filler beneath at a series of points successively to gradually move the slab to desired position.

1,929,279. **Pavement.** Andrew H. Irving, Berkeley, and Owen H. Robertson, Oakland, Calif., assignors to The Paraffine Companies, Inc., San Francisco, Calif. A pavement comprising a supporting substructure, and a traffic sheet overlying the substructure and comprising a fibrous layer coated with a wear-taking layer of viscous material slightly and slowly flowable under pressure and capable of coalescing after scarring so that a continuous surface is restored by wear, the wear-taking layer being filled throughout with a granular stiffening material to prevent the flowable material from hilling-up under a rolling load without impairing the surface restoring properties of the layer.

1,929,388. **Manufacture of Pavements.** Charles Augustine Mullen, Montreal, Quebec, Canada. The process of producing a paving mixture of the character described which consists in adding to the cold or but slightly warmed mineral aggregate a priming oil which has the capacity to coat the aggregate and to facilitate the diffusion of the next addition, then adding the bituminous cement, and then adding another and dissimilar volatile oil as a temporary fluxing oil whereby the mixture is so softened that it may be transported and laid without the application of heat and yet bear traffic after laying and compaction.

OCTOBER 10, 1933

1,929,809. **Street Marker.** Votaw S. Durbin, St. Louis, Mo. A street marker comprising a cast metal head provided on its underside with an integral keeper spaced from said underside, a spike cast integral with and projecting at right angels to the underside of said keeper and a flexible anchoring member mounted in said keeper having pointed arms projecting downwardly on opposite sides of said spike.

1,930,309. **Apparatus for Spreading Hot Asphalt.** James F. Gallagher, Chicago, Ill. Asphalt spreading apparatus, comprising in combination a wheeled frame, an elongated screed of hollow construction mounted on the frame crosswise of the latter, and a pump for circulating a hot fluid through the screed substantially throughout the length of the latter to heat the front and bottom surfaces thereof.

OCTOBER 17, 1933

1,930,957. **Road Chair.** Howard W. Nester, Worcester, Mass., assignor to Parker Wire Goods Co., Worcester, Mass. A road chair comprising a substantially flat extended base plate, an approximately horizontal intermediate section having upwardly and downwardly offset rod-engaging portions at one end thereof and having a rod-engaging portion at the other end extended downwardly to engage said base plate, and a brace member connected to said supporting portion and permanently secured to said intermediate section at a point between the ends thereof and substantially spaced from said ends, all parts of said road chair except the base plate being formed from a single continuous piece of wire rod.

1,931,174. **Traffic Signal.** Gilbert W. Withers, Atlanta, Ga. A traffic marker comprising a base, a series of anchoring brackets on one side of said base, the upper portions of said brackets forming guide members, securing strips associated with said base, said strips and base having portions so shaped as to co-operate to form an open-topped triangular groove, flexible letters having wedge-shaped bases extending into and filling said groove, and filler members in said groove between said letters.

OCTOBER 24, 1933

1,931,783. **Road Ripper.** Powers A. Wickes, Portland, Ore. A road ripper, the combination of a land traveling vehicle having a rigid frame, a beam frame hinged to the forward end of said vehicle on a transverse axis parallel with the axis of the vehicle wheels, digging teeth attached to said beam frame, stripper bars for said teeth disposed on the under side of said frame, and means for varying the inclination of said beam frame.

1,931,793. **Carrier and Heater for Pavement Crack Filling Buckets.** Clarence L. Gleason, Ames, Ia. A carrier and heater for pavement crack filling buckets comprising in combination a hollow body formed of a substantially horizontally arranged opening at its lower end to be secured to and fitting around an opening in the combustion chamber of a heater, the upper end of the body portion being formed with a vertical opening shaped and designed to receive and support a crack filling bucket, a hinged cover for the top of said body portion, said body having a circulating opening formed therein near the top thereof and so positioned that it will permit a circulation of heat through the body portion and outwardly and around the lower end of a crack filling bucket when the latter is supported in the open upper end of the body portion.

OCTOBER 31, 1933

1,933,469. **Mud Jack Sleeve for Highways and the Like.** Edmund J. Aylward, Neenah, Wis. For facilitating the pumping of filling material under surface material of a highway, street or the like, where the soil below such surface material has been washed away or has sunk, or where the surface material has raised and it is desirable to fill the existing void, a pavement having anchored therein as a permanent part thereof a tubular member passing through the pavement, said tubular member having both ends open and the lower end extending into the sub-structure below the pavement, and a closure for the upper end of said tubular member, said upper end of the tubular member and the upper face of the closure being flush with the upper surface of the pavement.

1,932,928. **Grit Distributing Machine.** Nikodemus Frisch, Augsburg, Germany. A sand or grit distributor with device for picking up the material to be distributed heaped on one or both sides of the road and for uniformly distributing the same on tarred or oiled road surfaces, comprising in combination with a vehicle, a shaft extending in the longitudinal axis of the vehicle, an engine connected to one end of said shaft adapted to rotate the same at a high speed, a rotatable centrifuging cylinder of truncated cone-shape mounted on the other end of said shaft, and a cover of resilient steel wire on the circumference of said cylinder to uniformly distribute same directly over the surface of the road.